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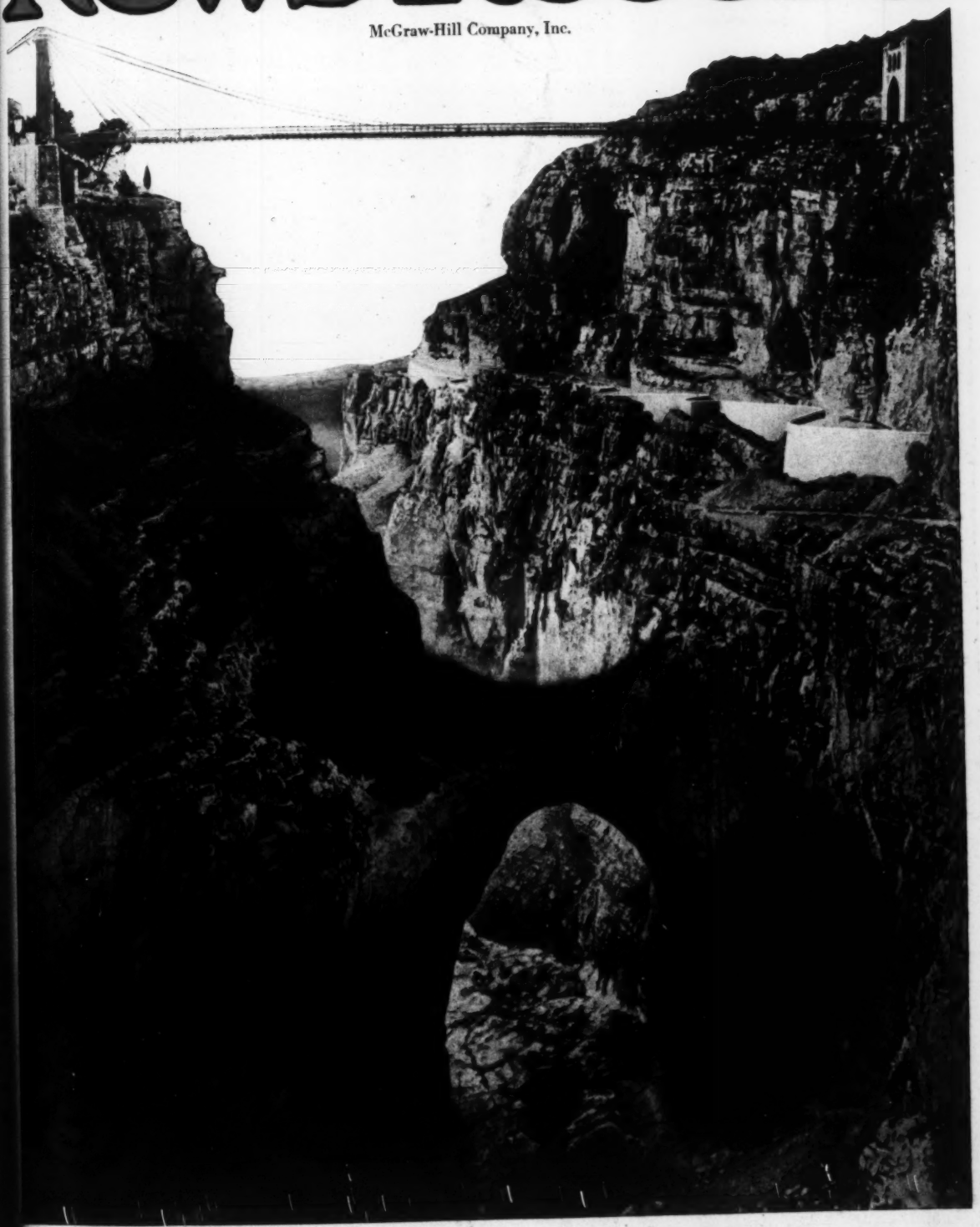

Possibilities of the Modern Suspension Bridge for Moderate Spans

Being a treatise by O. H. Ammann, setting forth reasons for wider use of the suspension bridge in highway service, based on a review of its development and recent advances. The cover photograph is of the Constantine Bridge, in Algeria, typical of French practice

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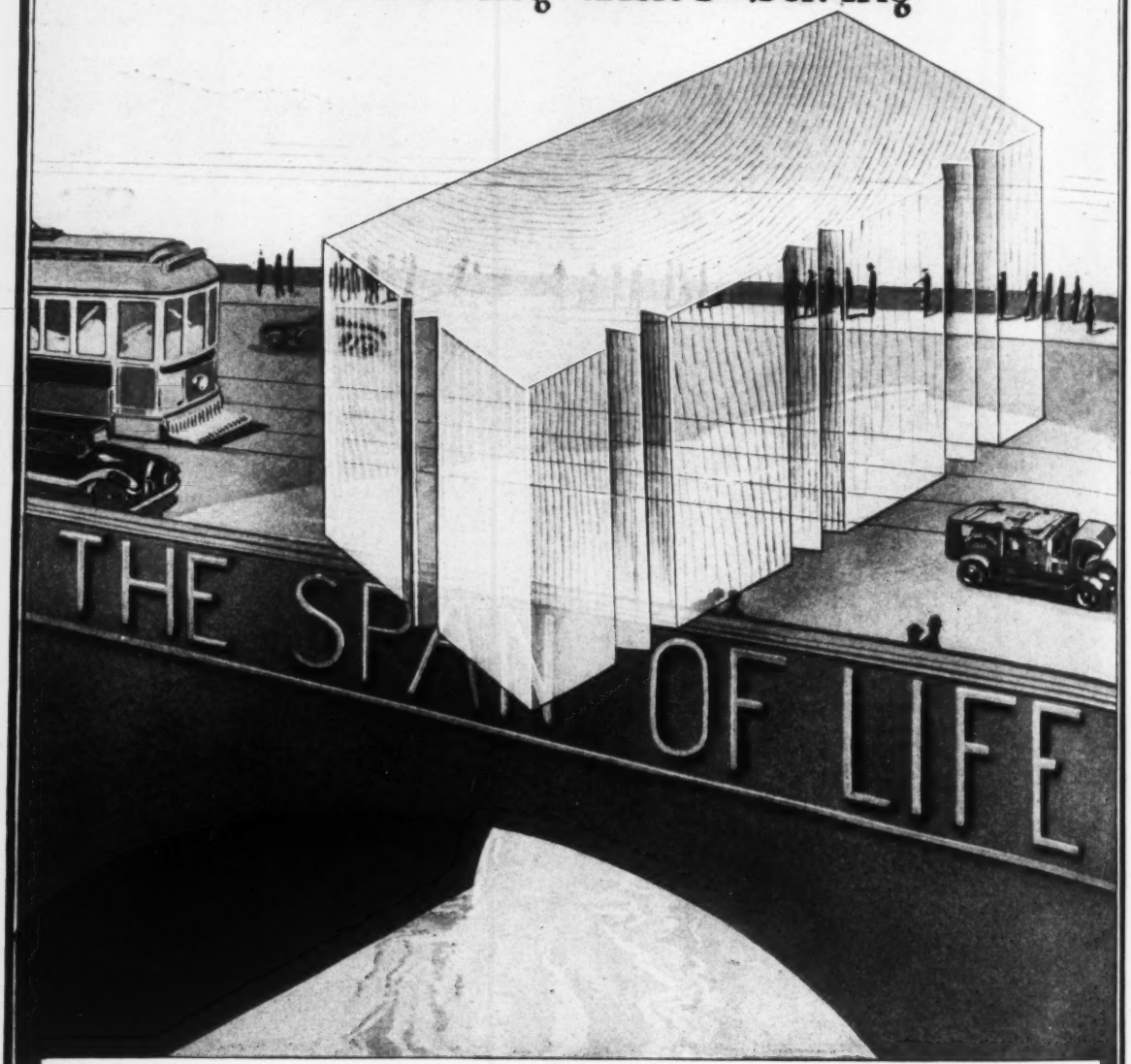

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ENGINEERING NEWS-RECORD

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E. J. MEHREN, *Editor*
FRANK C. WIGHT, *Managing Editor*

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A Rational Change

TWO cement companies, Marquette and Universal, have changed over from the barrel to the sack as the unit for selling and invoicing cement. This is a rational change that has against it only the minor objection of requiring more figures to express amounts. In all other respects the sack unit is preferable. The barrel has only historical interest in the domestic cement market, for the sack is the universal container and, because of its equivalent content of one cubic foot, is well nigh the universal unit of measure in estimating. The saving to both purchaser and buyer in avoiding the conversion factor 4 in reckoning back and forth from sack to barrel is a step toward economy well worth taking.

Industrial Relations Court Restricted

WHILE the Kansas Court of Industrial Relations is not killed by the recent decision of the United States Supreme Court, as most of the newspaper comments assume, its activities are unquestionably seriously restricted. The case in point was decided on a special issue, viz., the definition of an emergency which permits a state to assume that a business has a public interest and therefore subject to state control. The Supreme Court says in effect that in this case no such emergency did exist and therefore the state has no right to step in to "curtail the right of the employer on the one hand or of the employee on the other to contract about his affairs." Such a decision was foreshadowed when the Industrial Court tried to endow with public interest the wage relations of a small packing company and its workmen. Whether its authority will be denied in controversies of obvious public interest remains to be seen. Whatever be the practices of the court, the idea in its formulation was a good one. To protect the public in industrial warfare is a desirable function of the state. That both management and labor have been denouncing the court is fair evidence that it has not been partial and that it has intended, at least, to serve the public in the way for which it was designed. Its activities are bound to be kept within proper legal limits by court decisions, and it is hoped that it will learn by this latest decision just how far it can go in its future performance.

Interstate Power Transmission

THE latest group of decisions of the United States Supreme Court have particular interest to the engineer. We have already called attention to the rate cases with their reiteration of the reproduction-cost-new theory of value, and to the Kansas Industrial Court decision. A third case, more important in its implications than in its direct application, is the West Virginia natural gas ruling noted in the news columns this week. Natural gas is a disappearing commodity so that few need worry about its future disposition, but electrical energy, especially that generated by falling water, is the power source of the future. If it is to be permitted any state to prohibit the transmission of such energy outside of the state where it is generated—as the state of Maine now prohibits—the full development of the country will be seriously hampered. It is inconceivable that the barrier of state lines will be continued into that not distant future when so-called super-power schemes with intertied transmission lines become an economic necessity, but the tendency of certain eastern states is toward such an end. The Supreme Court's decision that natural gas cannot be kept within the state would seem to point to a future application of the same rule to the analogous electric transmission situation and to a reversal of the home use-only tendency of some of the states.

Cost of Detouring

COST of detours is an item which the average traveler seldom includes when he thinks of the expense of constructing roads. Engineers know that detours cost money, but even they do not give this cost the consideration it deserves perhaps because the main item is increased vehicle-operation cost, which is paid by the motor car owner and never gets onto the construction cost sheet of the engineer's report. Ordinarily the highway official keeps detours in good shape for travel and continues them no longer than he must because he respects the irritation of traffic driven out of its usual route. The fact that the detour adds to the car mileage of all who must travel that way is rather ignored in comparison, and perhaps wisely, since the traveler himself does not think of it greatly so long as the going is good. Yet in Wisconsin last year, as is told in this issue, an average of 1,320 vehicles a day for 81.6 days traveled 2.15 miles further than by the original route on 159 detours. At the reasonably low cost of 10c. a car mile for motor vehicle operation these figures give $3,686,000 as the extra operating cost due to detours in a state having a construction program no greater than that of perhaps a score of main road building states. This sum contains nothing for the direct cost of detour marking and upkeep nor does it include indirect costs which can be thought of, as for example drivers wages in motor-truck haulage. Detours are one of the costs of paved-road work and although they are an unavoidable cost and one which the improvement may return they are nevertheless real costs which the public at the moment must pay and their reduction is a worthy problem for any state highway department.

Fire-Protection Progress

NOT often is the meaning of forty years' advance in fire protection outlined so strikingly as in the case of the great Philadelphia trainshed which was destroyed last week. Under modern practice the fire would have been impossible; the large loss, and the

disorganization of a great railroad machine, would have been saved, and the imminent risk of a shocking list of casualties—which fortunately did not materialize under the circumstances—would also have been eliminated. The views of forty years ago tolerated the practice of placing a huge building of public assembly, filled with high values and during most of the twenty-four hours full of people, over a combustible floor and, what is much worse, a floor honeycombed with closed wood-lined spaces in which a conflagration might breed unnoticed. It is now many years since the bad fire hazards residing in such construction have been fully realized and largely made impossible in new building. The advance in both the science and the art of fire protection has been steady, but sufficiently unobtrusive to be little noticed by the general public. The continuance of existing hazards, created long ago, is a natural sequel. Moreover, even the most hazardous construction frequently finds itself validated, in effect, by a long period of safe existence, during which good fortune, coupled perhaps with constant watchfulness, keeps fires from happening, and the structure thus builds up a history of constant safety. Fortunately, the development of the study of fire hazards is sufficiently developed to be able to analyze even such time-approved risks and point out their dangers and how to correct them. In short, fire protection, though it may yet have far to go, has achieved most remarkable progress within the past two generations. In order that this advance may be fully applied to the public advantage, however, it is of utmost importance that existing hazardous points should be restudied, no matter how long their history of safety, and that such protection and safeguarding be added to them as the modern resources of the art make available.

A Neglected Resource

IF the resources of modern bridge construction are to be made fully available for the solution of the community's needs, more particularly in the field of highway construction, a restudy of suspension bridge possibilities is a necessary step. More or less by tacit consent the type has been relegated to a field of rather infrequent service, namely, long-span highway service, with only sporadic application to long-span railway or short-span highway crossings. It has been considered unsuitable for short spans, very largely, no doubt, on the ground of excessive flexibility under the high load concentrations of railways trains—or, to take the other side of the case, the cost and difficulty of making a suspension structure rigid under such service. Generalizing from the conclusions based on railway service is of doubtful validity, however; the fundamental requirements of highway service are quite distinct. It has been difficult to approach a more precise study of highway suspension possibilities, because no sound basis for fixing permissible deflections—that is, the required minimum degree of rigidity—has become established. Thus, the discussion presented by O. H. Ammann in this issue reopens a subject of marked present-day importance. With the aid of further thinking in the same field that other bridge engineers can contribute, it gives promise of building up new and sounder views of suspension bridges, and perhaps of initiating a distinct new departure in the art. The engineer will observe, of course, that if the subject is important to the public, by dealing with the possibility of more economical bridge construction, it is no less important to the bridge-building art itself. The restudy of the subject is in fact essential to well balanced progress of the art. The possibility is to be kept in view, moreover, that out of such study may develop new types of suspension bridge construction, born of the application of the greatly improved present-day resources of practice to a problem whose solution was mainly outlined a century ago.

Road Location by Legislature

REGARDLESS of other advantages or deficiencies the road bill just passed by the Illinois legislature is a glaring example of the evils of political interference with highway development. The governor has backed the bill strongly and that he will sign it is taken for granted, though this action will be in bad contrast to the vetoing of a somewhat similar bill by the governor of New York. This Illinois bill as originally drafted for roads estimated to cost $100,000,000 was condemned severely by numerous public bodies on account of its vicious character, the 30-year term of the bonds and the enormous expenditure which it contemplated. But during its consideration in the legislature it was amended enthusiastically and recklessly by the addition of numerous additional stretches of road proposed by individual members. In this way the mileage was increased to such an extent that the bond issue will be insufficient to provide for it. Furthermore, with these additions tacked on haphazard there is no systematic layout but rather an indiscriminate collection of improved roads. One saving feature is that the bond issue must still be submitted to public vote and not until November, 1924. But the fact that such a bill should be passed and signed is extremely discouraging to those interested in highway development. Political uses of the bill are foreseen in selecting the roads to be built from time to time, but even if an attempt should be made to carry out its provisions with a view to public benefit it would still fail to give the people of Illinois what it appears to promise them.

Work Ahead in Traffic Control

FOR some years the serious congestion of traffic in our cities was like Mark Twain's remark about the weather—"Every one complains about it, but no one ever does anything." Police regulation, of course, has grown in scope along with the increase in automobiles, but in the large centers, particularly, mere regulation has failed to keep step with the difficulties it was designed to meet, and where the police heads are frank they admit their inability to devise further means of reducing congestion or increasing safety in our city streets. Engineers everywhere now are beginning to see that the problem is one for the engineer to attack, but it is one of comparative novelty and therefore the methods of approach are neither obvious nor established. In nearly all of our cities the city engineers—or in some cases the engineering societies—have been studying how best to go about remedying traffic conditions, but they are all moving haltingly and, unfortunately, with little authority and little help from the authorities.

Some time ago this journal sent out a letter to the city engineers of all the sizeable cities in the country outlining the basic difficulties of the traffic problem and

asking for information as to methods and prospects in the various cities as well as for ideas on a proper method of approach to the general problem. The response has been very favorable. It shows that many minds are being turned to the study of the problem and history of human events has long ago proved that any problem is solvable if enough people get to work upon it. The tabulation of the replies must wait until some further information is received, but in order to aid those who are thinking along these lines it should be worth-while to record some of the high spots in the study of conditions that are revealed by this correspondence.

It is apparent that in few cities does the city engineer have control or even advise in the matter of traffic movement, though the advisory capacity is more frequent than the control. This relates to such matters as installation of traffic control signs, marking of parking spaces, or any of the details connected with regulation. With very few exceptions, the traffic is controlled by the police department, although in some excepted cases it is controlled by the department of public safety or a special traffic committee. Traffic increases are obviously taking place in every city, but only a few towns have made specific observations and even in these places the observation has been largely spasmodic.

Information concerning the evidence of pavement wear is very indefinite. Most of the city engineers state that there is considerable evidence of wear, but this is usually qualified with a statement to the effect that the pavement on which the wear is evident is old pavement that would probably have broken down under any traffic or waterbound macadam which cannot be expected to stand up under automobile conditions. In one city—Hartford, Conn.—there have been some very accurate tests on the wear of concrete pavement extending over nearly ten years, and these show that the average wear is not appreciable. The general opinion seems to be that the relation of volume of traffic to wear is indefinite.

The replies as to constructive moves the cities are making toward opening new streets, widening streets, rerouting traffic, etc., are more encouraging. In almost every case the cities either have started work on some such plan or have such a plan in preparation. Such developments as the parkway at Philadelphia going northeast from the City Hall, the opening of the new street by the South Station in Boston, the proposed motor driveway at Seattle, are all indications that where congestion becomes unbearable, the solution does lie in the rather expensive street openings. On account of this expense, however, this would seem to be a move of desperation. Some few cities have discussed rather academically the question of second-story streets and arcaded sidewalks with widening of the roadway to the old building line. This, too, involves heavy expense which up to date, at least, few cities have been willing or attempt.

The suggestions for a general policy of improving traffic conditions bear down heavily on the parking evil. Engineers are agreed that there must be strict control of parking within the limits of the congested areas, that no parking should be allowed in busy streets during rush hours or none at all in streets that are congested most of the day and that in such areas vehicles should park in side streets or in vacant lots that can be provided for this purpose. In cities where most of the streets in the business area are narrow and congested throughout the day no vehicles other than the necessary business cars should be permitted to enter; make all pleasure cars park outside of the restricted area and require the people to walk the necessary few blocks to reach their places of business.

Other suggestions for definite reform may be summarized as follows: Provide additional properly paved routes and, what is most important, educate people to use them; where streets are narrow, develop streets with one-way traffic parallel to each other and have them equally well paved to facilitate traffic movement; on such streets make surface cars conform to the one-way regulation and on all streets where street cars are operated where there is traffic congestion increase the distance between street car stopping points; provide streets with heavy special pavements for truck movement and require trucks to use them as far as possible; provide attractive routes for pleasure cars away from the more direct or economical routes used by business cars and trucks; increase the size of street intersections and order their form to be as nearly circular as possible; make general traffic control signs and methods of directing traffic movement general throughout the country so that strangers will not have to feel their way in strange cities, thus delaying traffic considerably; when a traffic rule is made stick to it for some time; wherever possible open up streets or roads as detours for through traffic passing by cities so that it will not be necessary for such traffic to pass through the congested streets; wherever conditions make it desirable use a system of block signals to control traffic; on streets where it is not possible to divert heavy traffic to side streets make the traffic move in two lines, so that slow moving vehicles will not restrict the movement of lighter cars; put street car lines on streets that are not required for dense motor-car movement.

These, then, are the specific suggestions. No one of them is new, but the collection of all of them may have some value to an engineer studying his local situation, for every city has its own peculiar conditions which can be met only by special applications of some general rule. It is obvious, however, that it behooves the engineers of each city to take into their own hands the study of this problem. If they do not, there seems to be little hope of its early solution. The police are at the end of their rope. The automobile associations, while doubtless interested, are biased in favor of vehicle traffic. The ordinary citizen can only observe and complain.

No better work can be done today by a local engineering society than the organization for study of the traffic situation in its own city. Study of the conditions is imperative, but more than study are required some specific recommendations which must be followed up by the power of continued appeal through all publicity means available. The work is peculiarly the duty of the engineering societies because the cities have not yet been educated up to the necessity of employing some one engineer to study the question, and no individual engineer will be deprived of his just work as he would be if the society were to make special recommendations regarding such things as water supply or sewerage, in which the city quite appreciates the necessity for expert advice.

Street congestion is the big engineering problem of the next decade. Will the engineering profession rise to its opportunities?

Possibilities of the Modern Suspension Bridge for Moderate Spans

A Reconsideration of Some Current Views of Suspension-Bridge Limitations, With Special Reference to the Development of the Type and the Influence of Recent Changes

By O. H. Ammann
Civil Engineer, New York City

IT MAY appear venturesome, in view of the quite general teaching of bridge literature that the suspension bridge is suitable only for very long spans, to come forward with a plea for more general use or rather revival of the oldest and most picturesque type of metal bridge. But the construction in recent years of a number of highway and light railway suspension bridges of moderate span—300 ft. and less to 800 ft.—and their successful service fully justify a discussion on the present-day merits and economic status of this type.

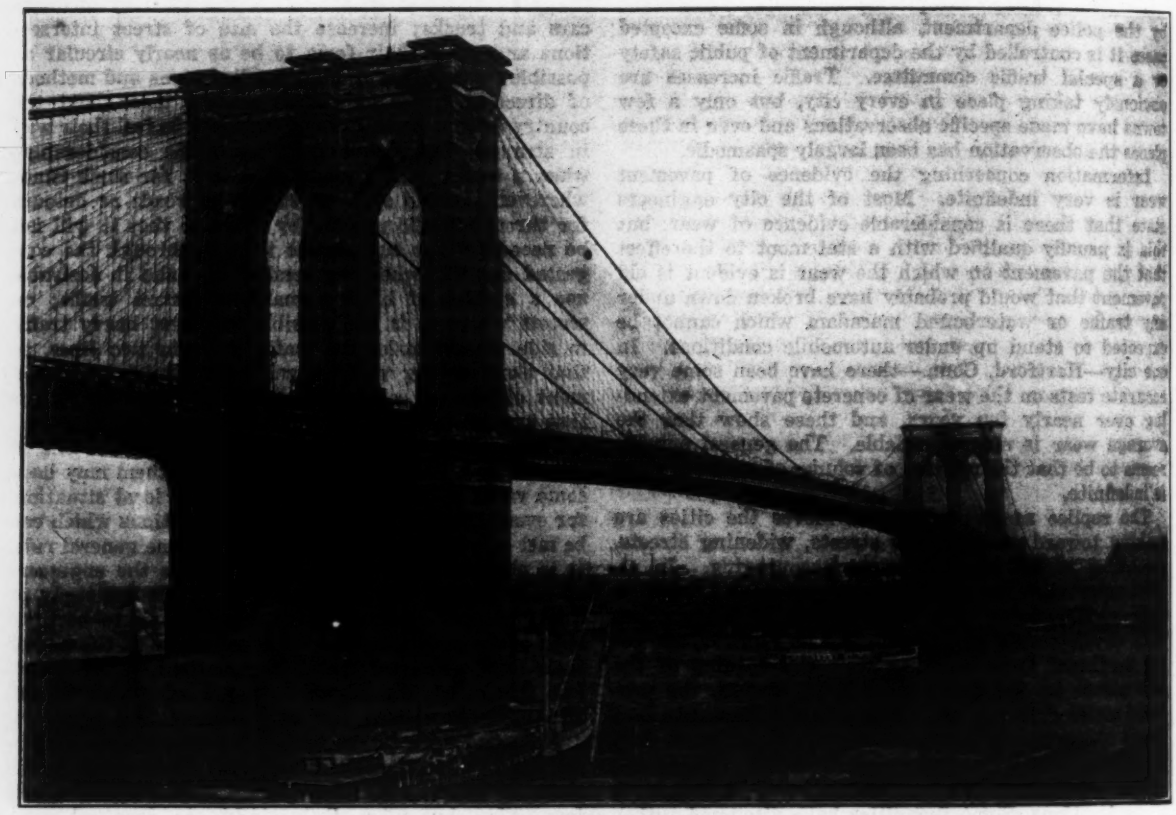


FIG. 1—BROOKLYN BRIDGE OVER THE EAST RIVER AT NEW YORK
This structure, with a main span of 1,595½ ft., is distinguished for the beauty of its lines. It has been in service for forty years, most of the time greatly overloaded; yet its main structural parts are of undiminished service value.

Recent Favoring Developments—One of the recent developments favorable to the suspension bridge of moderate span is the more general use of heavy floors in highway bridges, paved floors in place of the old light wooden floors, in railway bridges ballasted solid floors in place of open tie floors. To carry the heavier floor does not require as much increase of cost in the suspension bridge as in other types. Introduction of heat-treated eyebars of high strength and elastic limit at comparatively low price will also favorably affect the suspension bridge. It will permit the eyebar-chain bridge to compete with the wire-cable bridge and with other types of bridge dependent largely upon a lower-grade material for their compression members. It has been recognized in late years (as the result of the Quebec Bridge failure and of tests) that the eyebar chain has a greater margin of strength than compression members, and that relatively higher unit-stresses are justified for the former. This also should influence favorably the economy of the chain suspension bridge. Last, and not least, there is a noticeable tendency on the part of engineers and the public towards recognition of the value of aesthetics in bridge building.

The extensive development of highway traffic, which brings a large population into close touch with remote parts of the country, demands that roads and their bridges should meet certain aesthetic requirements. For this reason it may be expected that the suspension bridge, because of its pleasing appearance, will regain

its deserved position alongside the other types. It has always and everywhere been regarded as an aesthetically superior type.

It is not necessary to go outside this country to look for examples illustrating the natural beauty of the suspension bridge. Thus, the historically famous bridge at Newburyport, Mass., though crude in its proportions and construction, was so excellent in its general appearance that popular demand properly caused its reconstruction along almost identical lines. The Brooklyn Bridge, with its simple massive towers, is as famous for its beauty as for its size, and promises to maintain this position many years to come.

Part I. Development of the Suspension Bridge

For a full appreciation of the unfavorable status of the suspension bridge of moderate span it is necessary to review briefly the underlying causes.

Its Rise and Decline—Bridge building has undergone periodical modifications due both to the introduction of new materials and means of construction and to changes in human conceptions and tastes. The suspension bridge had its era in the first half of the 19th century. Subsequently it gave place to other types, and it is significant that in America, the country of origin of the modern suspension bridge, this type is today least appreciated except for very long spans, while in France, where it was introduced much later, it still retains a prominent position.

The cause of this decline lies largely in the early shortcomings of the suspension bridge. Having developed during the infancy of iron bridges, when the theory of stresses was unknown and methods of fabrication and details of construction were crude, it had to undergo more severe trials than the later types. The suspension bridge began to lose favor even before its nature was fully understood. Methods of proportioning the stiffening system were yet crude in 1850, when Stephenson, after a series of tests with models, decided in favor of a tubular beam for the Britannia bridge in place of the projected suspension bridge. About the same time Roebling was severely criticized for using the suspension type for the Niagara railway bridge, although his design represented a great improvement over former bridges and proved to be successful under conditions prevailing at that time.

Most suspension bridges existing today belong to the class of early bridges, which were defectively built. There is only a small number of properly designed suspension bridges.

Another unfavorable circumstance, applying to railway suspension bridges in particular, is found in the rapid increase in loads. While it is to the credit of the suspension bridge that such increases impair its safety less than that of other types, there resulted excessive deflections, due to the insufficiency of early stiffening systems—not, as is often claimed, to inherent lack of rigidity of the suspension type.

The suspension bridge has also undoubtedly fallen victim to the commercialization of bridge construction, which set in in the latter part of the 19th century, following the general trend toward cheap mass production coupled with growing lack of appreciation of aesthetics in bridge building. The suspension bridge does not lend itself as well to standardization and cheap fabrication as do some other types, to which it had to give way in spite of its superior appearance. This development has been apparent in Europe as well as in America.

Early Imperfections—The first rational suspension bridges were built in America by James Finley at the end of the 18th and the beginning of the 19th century. They were remarkably well designed structures for that time. Finley fully appreciated the importance of rigidity, vertically as well as horizontally, and he endeavored to provide for it by a stiff wooden floor. His chains, of forged wrought iron links, had a considerable sag, about one-seventh of the span. The floor was suspended from them by vertical rods; a strong railing assisted in stiffening the floor. The Merrimack River bridge at Newburyport, one of the most remarkable bridges built after Finley's plan, lasted for a century (built in 1809, replaced in 1909).

FIG. 2—CONSTANTINE BRIDGE, ALGERIA, TYPICAL OF MODERN FRENCH PRACTICE

Had Finley's sound principles of construction been adhered to many of the early suspension bridge failures would have been avoided. But instead of adhering to rigid floor construction, later builders resorted to various seemingly more economical arrangements, such as inclined stays, inclined planes of cables, flat catenary, etc., all of which proved of limited effectiveness.

Inclined stays, first introduced in England and widely used there in the early part of the 19th century, proved particularly fateful. A number of suspension bridges with such stays failed, on account of insufficient resistance to wind pressure and this led to the complete abandonment of that type in England. Not until 1840, when Rendel repaired the Montrose Bridge in Scotland, which had previously collapsed, did the effectiveness of a stiff floor again receive recognition. In the second half of the 19th century inclined stays were revived in America; in connection with the stiffening truss and

efficient lateral bracing, introduced meanwhile, they proved more effective, although they led to occasional trouble on account of uncertain distribution of the load.

Wire Cables—The advent of the wire cable constituted a retrogression, and was unquestionably responsible for much of the later mistrust in suspension bridges. The smaller weight of the wire cable, and more especially its greater elasticity due to higher working stresses, made the problem of vertical and horizontal stiffening in bridges of moderate span more difficult. Moreover, the wire cable, because of the small section of its constituent parts, was subject to rapid deterioration where not properly protected, and this has been the cause of many failures, to this day.

First introduced in America in 1816 in a bridge across the Schuylkill in Philadelphia, the wire-cable suspension bridge found application in the first half of the 19th century mainly in France and Switzerland. Primitive as its construction was in those days, it seemed to offer a cheap means of crossing deep valleys

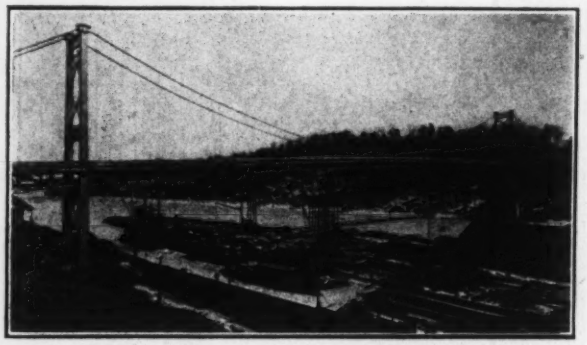


FIG. 3—RONDOUT CREEK BRIDGE AT KINGSTON, N. Y.
A link in a main state highway, this bridge was completed a year ago. Main span 705 ft. Stiffening trusses continuous between anchorages. Floor of reinforced concrete on steel.

and wide rivers. Many of these wire-cable bridges had no vertical and lateral bracing whatever. The wire cables were often carelessly erected and poorly connected and anchored, with the result that some strands were found to be strained beyond the elastic limit while others remained slack. The collapse of many of the early French wire-cable bridges, due to these causes in connection with overloading, shook public confidence in the suspension bridge and brought about the substitution of other types. Suspension-bridge building came almost to a standstill in France between 1850 and 1870. One of the most serious accidents was the failure of the bridge at Angers in 1850, which caused the drowning of 226 soldiers. During the years 1869 to 1881 not less than six wire-cable bridges collapsed in France alone. Not until after the French government in 1870 had set up rigorous specifications regulating the construction and maintenance of suspension bridges, and important improvements had meanwhile been effected by American engineers, was suspension-bridge building revived in France. The French type of wire-cable bridge was introduced in America by Charles Ellet several decades before, but here also its lack of rigidity was revealed, in the failure during a wind storm of the Ohio bridge at Wheeling in 1854, only seven years after its construction.

Effect of Improved Theory—The introduction of theory in proportioning suspension bridges for a time retarded rather than stimulated progress in the proper

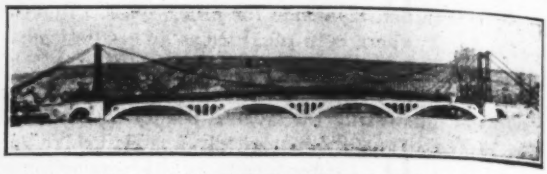


FIG. 4—MODERN FRENCH SHORT-SPAN SUSPENSION BRIDGE
Seine River crossing at Andelys, built 1917-18; span 496 ft.; Arnodin type.

direction. Navier's excellent treatise on suspension bridges (1823) inspired confidence in the unstiffened flat catenary, with the result that in contrast to the deep sag of $\frac{1}{4}$ in Finley's bridges a sag of from $\frac{1}{10}$ to $\frac{1}{15}$ was adopted in later bridges. Since the effect of temperature and elastic cable stretch is the more severe the flatter the catenary, it became necessary to give the floor more flexibility. The resulting loss in rigidity was not compensated by the smaller vertical undulations of the flat catenary under moving load, nor by its smaller horizontal motions due to wind. After Stephenson had made his extensive tests on models, the function of the stiffening trusses in increasing the rigidity of the floor became more clearly understood, and it was the privilege and merit of the American engineer, Washington Roebling, to use for the first time rational stiffening trusses in the Niagara railway bridge, completed in 1855.

Efforts to stiffen chain bridges by connecting two or more chains in a vertical plane were made very early, as in the Menai bridge at Bangor. The Weser bridge at Hameln, built in 1836 and still in use, was the first one in which a complete diagonal system between a pair of chains was introduced, but the depth of truss thus created in this and similar bridges of that time was insufficient. In 1860 such a system was used in the railroad bridge across the Danube Canal in Vienna. The replacement of that bridge after 24 years of service became necessary not for lack of rigidity of the system, but for defects of construction which were the cause of unequal stresses in the chains and excessive wear and tear.

The system of deep braced chain trusses proved highly successful in later highway bridges, such as the Seventh Avenue bridge across the Allegheny River in Pittsburgh, built by G. Lindenthal in 1884, and the Grand Avenue bridge in St. Louis, built by Carl Gayler in 1890. Stiffening trusses attached to the chain either above or below appeared in the second half of the 19th century and were successful. The Point Bridge in Pittsburgh, built by Hemberle in 1877, was the first one in this country. When tested after completion it showed remarkable rigidity, and like other bridges of the same type it has given good service since. Neglect and consequent deterioration, and greatly increased loads, made it necessary in 1904 to replace the floor of this bridge and carry out other repairs.

FIG. 5—RIVETED-CABLE TYPE—BRESLAU BRIDGE
Span 415 ft. between tower centers.

The Modern Suspension Bridge—Passing to a survey of suspension bridges built during the last twenty years, it is apparent that no change has taken place in broad conception of design. No new types have been introduced, but the proportions and details of the old types have been improved.

Distinct types are today preferred in different countries; the wire-cable bridge with separate stiffening truss in America, the wire-cable bridge with inclined stays in France and its colonies, and the chain or riveted-chord bridge with stiffening girder in Germany and Austria. It seems paradoxical that in America, the home of the cheaply manufactured forged eyebar, the wire cable should govern the field, whereas in Germany, where excellent wire is made and no special equipment for cheap manufacture of chain bars is available, the chain or even the riveted chord should be preferred. Obviously the selection of type is influenced very largely by other factors than mere economy, not in the least by adherence to precedent and conventional practice.

American Practice—The modern American suspension bridge is typified in the Manhattan Bridge across the East River in New York. Its characteristics are wire cables suspended from slender steel towers or bents and stiffened by parallel-chord stiffening trusses. Several smaller bridges of this type with spans ranging from 775 to 400 ft. have been built in recent years, notably the Ohio bridge at Parkersburg, built by Hermann Laub in 1916, and two bridges built by H. D. Robinson, one across the La Grasse River at Massena Center, N. Y., in 1911 and one across Rondout Creek at Kingston, N. Y., in 1922. The only distinction between them is the degree of continuity of the stiffening trusses. Continuous trusses, as adopted in the Kingston bridge, represent an improvement as regards both economy and rigidity.

While these bridges give good service for highway traffic under present loads and may be economical in first cost, they cannot be regarded as the most advanced type suitable for moderate spans. For that we must look to the eyebar chain, which has the advantage of greater weight and greater resistance against corrosion. Eyebar chains moreover permit efficient attachment of the stiffening web members, with which they form a unified and rigid main carrying system.

French Practice—Modern French suspension bridges, like the American ones, are wire-cable bridges, but they embody two features that make them very economical, namely: the use of wire ropes instead of parallel-wire cables and the arrangement of inclined stays. Although wire ropes have a somewhat lower strength than straight parallel wires this disadvantage is more than offset by their lower cost of erection. The ambiguity of stresses which caused trouble in earlier bridges with inclined stays has been minimized in the modern French bridges by partial omission of the vertical suspenders and by careful adjustment of the stays during erection. In the system introduced by F. Arnodin, the builder of many of the modern French suspension bridges, the inclined stays extend from the towers to near the quarter-points of the span, while the middle portion of the span is suspended from the cables.

These bridges have spans as low as 250 ft. and up to 900 ft. The more recent ones have a reinforced-concrete floor. The bridge at Constantine, Algeria, which with a span of 540 ft. crosses a gorge 570 ft. deep, is one of the most remarkable examples of this type.

The Gisclard system is less appealing to the eye, but appears to be particularly adapted to railway traffic. In that system the inclined stays extend across the entire span and form a main carrying system in which the material is utilized in tension to the greatest possible extent. The system was first used for a number of short-span highway bridges in the French Congo, and proved so successful that in 1907 it was adopted for the 510-ft. span carrying the electric railway line between Villefranche and Bourg-Madame in the Pyrenees. The maximum live-load deflection of this bridge under test was only 6 in., or 1/1000 of the span. The system has since been used in bridges of moderate span carrying light railway traffic; they are said to be free of vibration. In a competition in 1914 for a highway bridge of 430-ft. span across the Seine at Vitry the Gisclard type proved cheaper than either beam, cantilever, arch or combination system.

Chain Bridges—Only a few suspension bridges have been built in central Europe, and nearly all are of the chain type. The Elizabeth Bridge, built in 1903 in Budapest, is the most prominent of them, and with its span of 950 ft. is the longest suspension bridge in Europe. Other prominent examples are the Kaiser bridge in Breslau, with a span of 415 ft., the Borsigsteg in Berlin, with a span of only 167 ft., and the bridge across the Rhine at Cologne, completed in 1915, with a span of 605 ft. None of these chain bridges represents the most economical type, and in their selection among competitive designs economic requirements were outbalanced by aesthetic considerations or local policies.

FIG. 6—A SMALL CHAIN-CABLE BRIDGE
The Borsigsteg at Berlin, Germany; span 167 ft.

Part II. The Suspension Bridge Compared with Other Types

A bridge must be judged above all by its usefulness as a means of communication. It should afford to the traveling public the same feeling of security, comfort and pleasure which is enjoyed on *terra firma*. That requires confidence in the safety of the bridge, a certain minimum degree of rigidity and, as far as possible, open view, undisturbed by a net of steelwork. Even for moderate span-lengths these requirements can be met in a properly designed suspension bridge as well as, or better than, in other types.

Safety and Permanence—There is probably no element in a steel bridge which, after recent experiences, can inspire as much confidence in its safety as a cable, or, even more so, an eyebar chain. While many early suspension bridges have failed by the breaking of cables or chains, the causes are as outlined heretofore and do not lie in inherent weakness or low margin of safety.

Further, these early failures of suspension bridges are overshadowed by a much larger number of later, even very recent, failures of bridges of other types—small truss highway bridges broken down by a motor vehicle bumping against a web member, and the greatest railroad cantilever ever projected, destroyed by the buckling of one of its compression-chord members. In a suspension bridge the possible hitting of a suspender by a vehicle will at most cause local damage, and even the buckling of a truss chord is not fatal.

The safety of a bridge is in a way evidenced by its durability, as this indicates the ability of the bridge to withstand emergency conditions, increase in live-loads and deteriorating effects. There are over fifty suspension bridges of moderate span here and in Europe which have attained a life of half a century. More than a score, mostly chain bridges, date from the first half of the 19th century. At the top of the list are as centenarians the Merrimack River bridge at Newburyport, the Tweed bridge at Berwick (1820), and the Rhone bridge at Tain (1823). Closely following are the Menai bridge at Bangor and the bridge at Conway Castle, both built by Telford in 1826. All the foregoing are chain bridges ranging in span from 240 to 580 ft. The Saane bridge at Fribourg in Switzerland (1834) is the oldest existing wire-cable suspension bridge. Its span of 870 ft. was for many years the longest. No other type of steel bridge can show such a record.

Many suspension bridges of moderate span have lasted longer than bridges of other types built contemporaneously. Roebling's Niagara bridge, often cited as a discouraging example of a railway suspension bridge, served its purpose for 42 years, whereas many more modern simple-span railway bridges did not last over 25 years. It is a significant coincidence that the Victoria bridge at Montreal, a tubular girder, a type which at the time of its building was a rival of the suspension bridge and by many was considered superior, was built and replaced almost simultaneously with the Niagara bridge.

Rigidity—There is probably no argument which has been used so indiscriminately and unjustly to condemn the suspension bridge as that of its alleged lack of rigidity—and this in spite of the proof to the contrary which is given by well designed structures that are in satisfactory service in many countries.

It is true that the suspension bridge in general is not as rigid as some other types, but that does not imply that it is insufficiently rigid for the needs of traffic. The extreme rigidity of a simple span, for instance, is incidental to its most economical proportions, and is not necessarily a virtue or a point of superiority. Whether a very rigid structure is safer and more durable than an elastic one is by no means a settled question. Synchronized motions of the load and vibrations of the structure may subject the rigid structure to much more wear and tear than the elastic one. Suspension bridges may be designed with any degree of rigidity from that of a flexible cable to that of a simple truss span, but economy demands minimum rigidity compatible with traffic requirements.

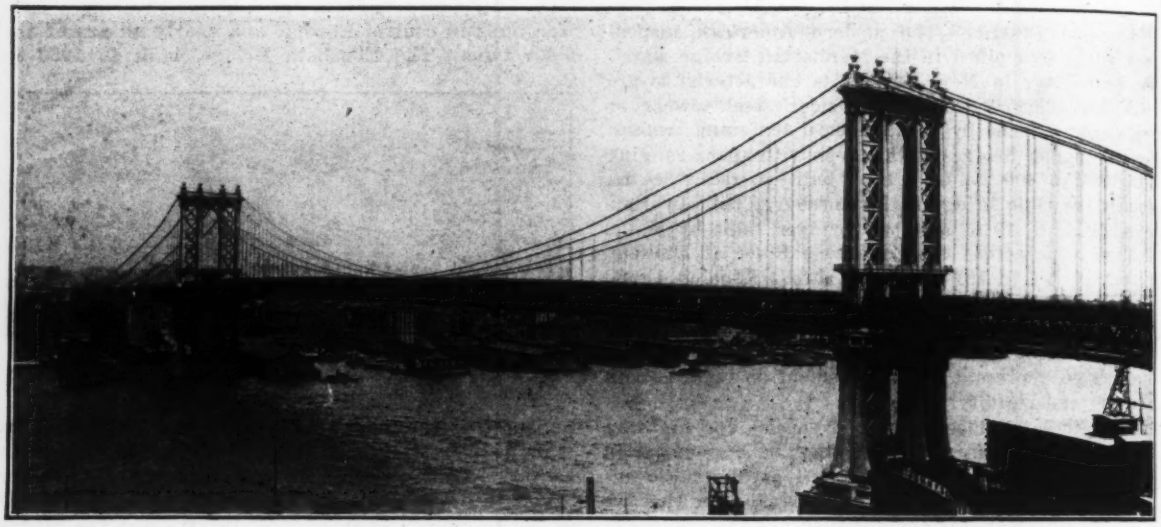


FIG. 7—MANHATTAN BRIDGE, MOST RECENT OF THE LONG-SPAN SUSPENSION BRIDGES AT NEW YORK
Carrying a double deck designed for heavy loading, this structure differs structurally from the Brooklyn Bridge chiefly in its steel towers, two-hinged stiffening trusses, and absence of diagonal stay ropes. With its parallel-chord trusses, it is typical of spun-cable suspension bridges as developed in American practice.

The deflections of a properly proportioned stiffening truss have nothing in common with those of an unstiffened cable. The former are limited by the elastic changes of the material, while the much larger deformations of the unstiffened cable are due mainly to the displacement of the line of equilibrium of the cable; in a large cable its elastic deformation may play an important part.

Deflection Figures—In a suspension bridge of 300-ft. span carrying a light highway floor the calculated deformations of the unstiffened cable are about eight times as large as the deflections of the economically stiffened cable. For a span of 3,000 ft. the ratio is about as three to one. The fact that so many old, unstiffened or improperly stiffened, suspension bridges of comparatively short span and light floor have given good service for generations should therefore dissipate any concern about the rigidity of properly stiffened modern highway suspension bridges with spans as low

as 300 ft., particularly if a heavy paved floor is used.

Such reasoned considerations are fully confirmed by actual observations. Old highway suspension bridges have been observed to deflect as much as 1/80 of the span under load, without signs of weakness in the structure and without serious impediment to the traffic. In several cases where older bridges have been reconstructed by providing a proper stiffening system the deflections have been reduced to one-fifth or less of their original amount.

Let us now see whether and how far the minimum required rigidity is compatible with economic and aesthetic proportions of a stiffened suspension bridge. For that purpose we will assume the most flexible type of suspension bridge, the wire-cable bridge with separate stiffening truss. A short simple-span highway bridge is generally considered sufficiently rigid if its depth is not less than $\frac{1}{2}$ of its span length. That corresponds to a maximum live-load deflection of about 1/750 of the span. A two-hinged stiffening truss of a suspension bridge, to have the same maximum rigidity, should have a depth of not less than $\frac{1}{4}$ of its total span or $\frac{1}{2}$ of its half span (because each half deflects very nearly as a simple span). Such a depth is excessive for economy and good appearance, and therefore the suspension bridge is not well adapted for very short spans, say below 300 ft.

As the length and width of the bridge and therewith the number of traffic units necessary to produce maximum deflection increase, it becomes permissible to allow relatively greater deflections under maximum load. In other words the permissible rigidity is not to be measured by the deflection from a maximum possible load combination, but by the deflection produced by a traffic unit, as a single truck or a group of a few trucks, an electric car or a single train, because the deflection from a combined load is not only the less probable and the less frequent the greater the number and variety of traffic units, but is produced only very gradually and is therefore neither disturbing to the traffic nor detrimental to the structure as long as the stresses remain within permissible limits.

For a highway bridge of 300-ft. span and a roadway for more than two lanes of vehicles the probability of the deflection ever reaching even one-half of the maximum is extremely remote, and it is therefore permissible in a suspension bridge of that size to make the depth of the stiffening truss about 1/40 of the span. As the span and width increase the depth may decrease further, so far as rigidity is concerned. A continuous stiffening truss will permit a relatively smaller depth than a hinged truss.

The Kingston highway bridge, 705-ft. span, has a continuous stiffening truss with an average depth of 12½ ft. or 1/56 of the span. In the Cologne chain bridge, 605-ft. span, the depth of the continuous stiffening girder is 1/54 and the theoretical maximum deflection is 1/547 of the span. Cable suspension-bridge designs submitted in competition showed theoretical deflections of as much as 1/316 of the span, which was however not considered excessive by the able engineers who composed the jury. In the Brooklyn Bridge, 1,595-ft. span, the depth ratio is only 1/93 and the maximum theoretical deflection must be close to 1/300 of the span. Yet all these bridges are known to have ample rigidity under actual traffic conditions.

The Point Bridge in Pittsburgh, one of the first chain bridges with stiffening truss attached to the eyebar chain, when tested after completion showed a deflection at the quarter-points of 2¾ in. or only 1/3500 of the total span under a load of two-thirds of the maximum, and the vibrations did not exceed $\frac{1}{8}$ in. either laterally or vertically.

For railway bridges the deflection is generally limited to 1/1000 of the span length. Moreover, a single traffic unit, as a heavy train, may produce nearly full deflection in case the bridge carries only one or two tracks. If the number of tracks is not more than two the suspension bridge for railway traffic is therefore properly restricted to very long spans. But if the number of tracks is greater, or if highway traffic is added, and especially if a ballasted solid floor and a braced-chain system of suspension are used, the railway suspension bridge becomes practicable with ample rigidity for spans as low as 800 ft. This was proved by a suspension bridge design made by G. Lindenthal for the four-track Hell Gate bridge in New York (Trans. Am. Soc. C. E., Vol. 82, 1918, p. 852), which compared very favorably in economy and rigidity with other designs.

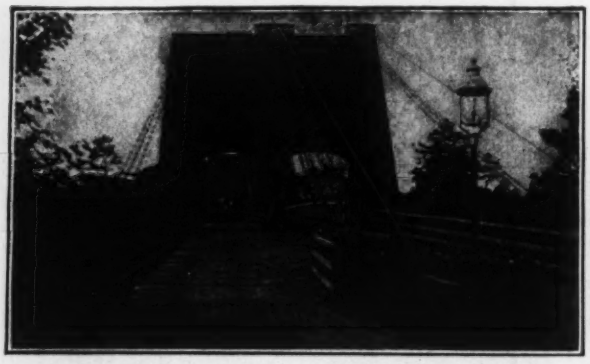
FIG. 8—RAILROAD SUSPENSION BRIDGE, GISCLARD SYSTEM
Span of about 500 ft. across the Luzege at Lapleau, France.

Several suspension bridges of comparatively short span have been built in France for light narrow-gage railways. They are said to give very satisfactory service, vibration being practically absent.

Economy—Much has been written on the comparative cost and the so-called economic span limits of the different types of bridge. While the value of such economies cannot be questioned, attention must be called to the fact that, unless all possible latitude is allowed in the many factors entering into such investigations, the results may be not only valueless but highly misleading.

There are, to be sure, certain economic laws which are applicable if broadly applied, but most bridge economics have been based on narrow assumptions or personal preferences of the analyst as to the basic elements —specifications for loads, stresses and details, character of foundations, prices, and the like. This is clearly shown by the widely divergent conclusions of different investigators. One authority finds a continuous bridge 20 per cent cheaper than a simple-span bridge, while another finds just the reverse. Two different current specifications require, for the same bridge and live-load, sections differing by as much as 40 per cent. The lower economic limit of a railroad suspension bridge is found by one authority to be 2,700 ft., while another one finds the suspension type more economical than any other type for a span of 800 ft. Likewise the economic limit of highway suspension bridges is found by different persons at all the way from 400 to 1,500 ft.

Competitive bids, based upon given specifications, have in one particular case of an 1,800-ft. span resulted in the victory of the cantilever over the suspension bridge, while in another case of a 430-ft. span the suspension bridge was victorious over all other types, with a good margin.



OLD "CHAIN BRIDGE" AT NEWBURYPORT, MASS.
The old bridge reached an age of 100 years and was so much admired for its appearance that the law providing for its rebuilding specified that its successor should be rebuilt to similar lines.

NEWBURYPORT BRIDGE AS REBUILT

It must also be considered that the results of any economic analysis are subject to radical modifications in comparatively short periods, due to changes in the relative cost of materials, in shop practice and in facilities and methods of erection. As previously mentioned the introduction of the heavy paved floor in highway bridges and of the ballasted solid floor in railway bridges is favorable to the suspension bridge, for with increasing dead-load the weight of the stiffening system of a suspension bridge decreases, whereas the total weight of a simple truss or cantilever increases nearly in proportion to the added weight. This favorable influence is particularly marked in short spans, since in these the added weight of a solid floor forms a large proportion of the entire dead-load.

The introduction of a comparatively cheap steel for eyebars will also favorably affect the economy of the suspension bridge, for it will favor the braced chain, which, on account of its superior rigidity, is better adapted to short spans than the wire cable. High-grade steel for riveted members, allowing high stresses in the stiffening system, also tends towards comparatively greater economy in suspension bridges.

Relative Unit Stresses—Economic comparisons or competitive designs are often based upon specifications which discriminate against the suspension bridge. In fact most of the leading specifications are not applicable to that type. Thus, it is not fair to apply the same rigorous specifications for loads or unit-stresses to an ordinary truss bridge and to the stiffening system of a suspension bridge. This has been recognized in some designs of suspension bridges, but is not generally appreciated. The stiffening system is not essential to the safety of a suspension bridge, but merely produces rigidity, and if it breaks, as has happened, the bridge will not collapse and the damage can be repaired. But if a member of an ordinary truss breaks the whole bridge will go down, and the truss therefore must be designed with a greater margin of safety. Further, a stiffening system (owing to its greater flexibility) is not subject to the impact stresses of a truss bridge.

It is reasonable, also, to allow somewhat higher unit-stresses in the cables or chains of a suspension bridge than in tension members of trusses, because the former are comparatively free of secondary stresses from all sources. They are also less subject to shock and vibrations.

The most economical type and proportions of a suspension bridge depend, more than those of a truss, upon the character of load and the comparative quality and cost of material in cables or chains, stiffening trusses and towers, and require careful investigation in any particular case. It is found, however, that some of the investigations into the economy of the suspension bridge are based upon more or less arbitrarily selected type and proportions, not always conducive to economy.

The economic span limit between two types of bridge is very sensitive to changes in the basic assumptions. Graphically it is obtained as the intersection point of two cost curves that are nearly parallel. It jumps considerably with a comparatively slight change in the relative location of these curves as affected by the assumptions.

While, therefore, the question of ultimate economy is too complex to justify exact figures in a general comparison of types, and a proper comparison in any particular case can only be had by competitive bids based upon rational specifications, the following general conclusions may be set down:

Under favorable conditions, rational specifications and proper selection of type, proportions and general arrangements, the suspension bridge for highway traffic will be found economical for spans of 300 ft. and even less. For railway purposes the suspension bridge can compete with other types on spans as short as 800 ft.

Some of the Legal Aspects of Land Surveying

Supreme Court Decisions Affecting Technical Problems Discussed and Summarized

By M. E. Chamberlin
Civil Engineer, Montevideo, Minn.

THE PRINCIPLES and results of land surveying are vital factors involved in property rights. Hence it is an important element of a state's economic system. It has long constituted a considerable part of most surveyors' and numerous civil engineers' professional work. By reason of obliterated original monuments, conflicting sub-divisions, ambiguous deed descriptions and technical discrepancies in earlier surveys, land surveying is no longer simply the application of mensuration.

Rarely is there now a call for a wholly original survey. A re-survey often constitutes the entire problem, and in most cases is far more complex and difficult than the original. Its successful solution requires the exercise of a judicious mind.

Though without authority, the surveyor who is employed to make a re-survey must often act as both judge and jury, interpreting the law, hearing the testimony, sifting the evidence, weighing the facts, and making a consistent decision. Having encountered such perplexities the conscientious engineer usually dodges when requested to make a re-survey.

Since the land office officials of the U. S. Department of the Interior have ruled, and supreme courts have repeatedly held, that the purpose of a re-survey is to replace lost or obliterated monuments and boundary lines in their original location rather than where they evidently should be, the surveyor should be especially diligent in securing every possible piece of evidence which may have any bearing on the problem.

The available evidence may consist of testimony of biased land owners, fragments of nearly obliterated monuments the history and identity of which are unknown, faulty deed descriptions, erroneous plats, and inconsistent original survey field notes. This mass of evidence may seem to present, and often does present, an incompatible, puzzling problem. Hence the necessity that the surveyor possess pertinent legal knowledge.

The degree of accuracy obtained in land surveying should be somewhat in proportion to the market value of the tract, or the nature and importance of the project hinging on the results of the survey. In this connection possible future litigation should be an incentive to the surveyor to solve the problem according to the most applicable legal decisions. "The field notes," one author asserts, "should be full and explicit, and, especially in re-surveys, should state in plain, concise words every material fact in regard to the work." This advice applies especially to field notes which must be used as a guide in writing deed descriptions.

A competent surveyor would seem to be the proper person to write deed descriptions; a highly important form of professional service. Every such description should be clear, concise and complete.

The following abbreviated citations indicate the attitude of various supreme courts on questions often involved in the land surveyor's problems:

Surveyors have no more authority than other men to determine boundaries of their own motion.
Cronin vs. Gore, 38 Mich. 381.

New surveys disturbing old boundaries are not to be encouraged. *Toby vs. Secor, Wis. N. W. Rep. Vol. 19.*

A deed must be construed according to the condition of things at the date thereof.
Quillen vs. Betts, Del. 39 A. 595.

The evident intention of parties to a deed must be given effect. *Hale vs. Docking, Kan. 51,798.*

A grant of land bounded by a highway takes to the center of the highway. If it be designed to exclude the highway, it must be so stated. *Champlin vs. Pendleton, 13 Conn. 23.*

A conveyance by metes and bounds will carry all the land included within them, although it be more or less than is stated in the deed. *Butler vs. Widger, 7 Cow. N. Y. 723.*

A long established fence is, in this case, better evidence of actual boundaries, settled by practical location, than a re-survey made after the monuments of the original survey have disappeared. *Diehl vs. Zauger, 39 Mich. 601.*

When the interested parties have long acquiesced in the location of street lines in supposed conformity to the plat, these lines should be accepted as fixed monuments in locating lots and blocks contiguous thereto.
Van den Brooks vs. Coreon, 48 Mich. 283.

Where the division line between lands of adjoining landowners is unknown, they fix its location by parol, each party mutually agreeing thereto and acting thereon, which agreement is binding, but if the original line is known, then the transfer of the land between the two lines must be in writing. *Jenkins vs. Trager, 40 F. 726.*

A large per cent of property line disputes involved in re-surveys are settled according to the advice of the surveyor in conformity to the principles set forth in the above citations; and many more might be so settled to the advantage of both parties.

In applying the general rule to relocate obliterated boundaries, the order of application of the evidence should be: 1, as to natural objects; 2, as to artificial marks; 3, as to courses and distances. (As to area, should be included as 4. Author.) *Yanish vs. Tarbox, 51 N. W. 1051.*

Where the description in a deed refers to a survey or plat, the evidences of such survey and the particulars shown on the plat are to be given the same consideration as though expressly cited in the deed.
Maddox vs. Turner, Tex. 15, S. W. 237.
Davis vs. Rainsford, 17 Mass. 219.

Seventy acres lying in the southwest corner of a section is a good description, and, in absence of definite evidence to the contrary, will be in a square.
Walsh vs. Ringer, Ohio 327.

Where a plat shows all the lots except one, as lot A, to be of equal width, and the width of all the lots, including lot A, is clearly indicated, and a re-survey shows that the whole block exceeds the total platted distance the excess must be apportioned among all the lots in proportion to their respective platted widths.
Pereles vs. Magoon, Wis. 46 N. W. 1047.

The general rule that riparian rights extend along straight, converging lines to the center of a meandered lake-bed (*Shell vs. Matteson, Minn. 83 N. W. 491*) does not hold where the shore line of the lake is so irregular that such a uniform sub-division would be inequitable.
Scheifert vs. Briegel, Minn. 90.
Jones vs. Johnson, 18 How. U. S. 100.

Regarding the last-cited decision some legal authorities apply the original common law rule that riparian rights extend to the deepest point of the lake or channel, on the theory that the use of the water, as it recedes, is the chief consideration.

Water Supply and Irrigation Works, Wichita Falls, Tex.

Earth-Fill Storage and Diversion Dams Impound 545,000 Acre-Feet—Canal System Planned to Irrigate 110,000 Acres

By Albert S. Fry
Morgan Engineering Co., Memphis, Tenn.

A LARGE hydraulic-fill storage dam, a smaller diversion dam 15 miles downstream, and a system of main and lateral canals are under construction near Wichita Falls, Tex., by Wichita County Water Improvement District 1 to furnish a water supply for the city of Wichita Falls and to irrigate 110,000 acres of agricultural land in the valley of the Wichita River. The works will cost about $4,500,000.

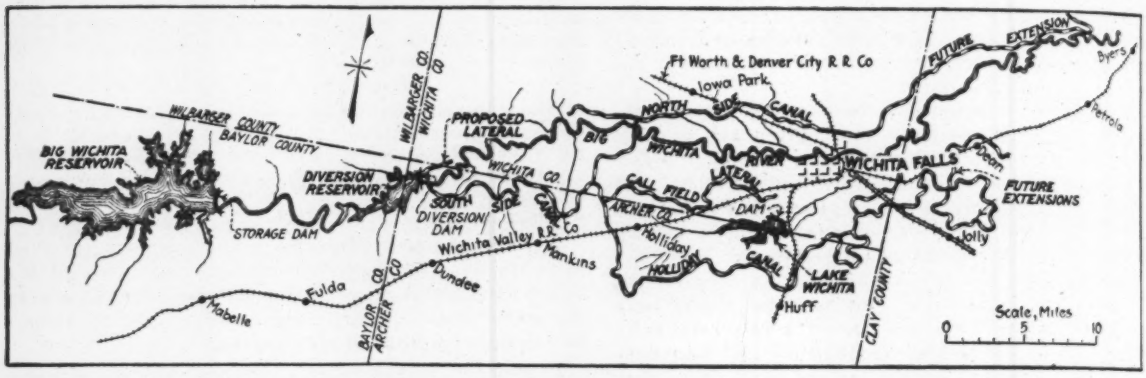
Above the storage dam site, which is 40 miles west of the city, the Big Wichita River has a drainage area of 2,650 square miles. Like many of the water courses in the arid and semi-arid regions it is a flashy stream. The river bed is entirely dry at certain seasons of the year, with only a small underground flow through the sand, but at flood times the channel carries a large volume of water. The land in the drainage area above the storage dam is of little value as it consists for the most part of broken country badly eroded and cut by numerous gulches and breaks. Below the diversion dam the valley widens into a fertile plain of bottom lands several miles wide. When supplied with a dependable source of water, after the irrigation works are constructed, this area will be very profitable for cultivation.

The average annual rainfall in this region is 27 in., and this rainfall, if properly distributed throughout the growing season, would be sufficient for agricultural purposes. However, the annual rainfall has been as low as 15½ in., and there are periods of drought nearly every year which cause the crops to perish. In consequence it is essential for the successful cultivation of crops in this valley year after year to supplement the natural rainfall with irrigation.

The available records of discharge on Wichita River indicate that there is a sufficient quantity of water both for water supply for present and future demands of Wichita Falls and for the irrigation of the agricultural lands.

Storage Dam—The storage dam is a hydraulic-fill earth structure 7,500 ft. long with a maximum height of 100 ft. It contains about 1,500,000 cu.yd. of earth. The storage reservoir behind the dam is 13 miles long and 3½ miles wide. At the level of the spillway it has a storage capacity of 500,000 acre-feet and covers an area of 20,000 acres. The major portion of the embankment, 3,000 ft. long, is being constructed by a 20-in. electrically-operated hydraulic dredge. Underneath the dam a cutoff trench has been constructed and backfilled with impervious puddled material. Steel sheet piling extends below the cutoff trench into a hard shale formation across the river channel and valley.

Under one side of the dam are six concrete conduits. Four of these conduits will be closed permanently after the dam is completed, their purpose being to provide for the discharge of flood water during construction before the spillway is built and is effective. The remaining conduits will be used to control the discharge from the storage dam to the diversion dam.



MAP OF BIG WICHITA RIVER IRRIGATION AND WATER SUPPLY PROJECT

A circular concrete spillway with a crest length of 565 ft. will protect the dam from large floods. This spillway, with a depth over the crest of 10 ft. and a freeboard of 5 ft. to the top of the dam, will discharge about 75,000 sec.-ft., which is equivalent to a runoff of slightly more than 1 in. in 24 hours over the total area of the watershed. An emergency spillway of 125,000 sec.-ft. capacity will provide for extraordinary floods. The capacity of the spillways was fixed after a study of storm rainfall and recorded floods in the vicinity of the dam. In general, large storms that pass through central and eastern Texas originate in the Gulf of Mexico and swing northerly and easterly. Some storms, however, have moved in a northwesterly direction nearly to Wichita Falls. Study of the movement of storms in Texas showed that it was possible for a storm of much greater intensity than any so far recorded to occur some time over the drainage of the Wichita River and that it was possible for such a storm to come when the reservoir was full. Such being the case, it was necessary to provide ample spillway capacity. The topography at the dam site makes it possible to secure a large emergency spillway capacity at a low cost, which accounts for the large capacity adopted for the emergency spillway.

Diversion Dam—The diversion dam is an earth dam with a concrete overflow spillway at one end. This dam is 4,200 ft. long and will have a maximum height of 55 ft. above the river bed and a height of about 40 ft.

above the valley floor for the greater part of its length. The concrete spillway is 310 ft. long and is a gravity overflow section designed to discharge 100,000 sec.-ft. with the water 15 ft. deep over the crest. The earth section of the diversion dam contains 550,000 cu.yd. The upstream slopes are 3 to 1 and 2 to 1 and the downstream slope is 2 to 1. The upstream face will be paved with a 12-in. layer of rock riprap laid on a 6-in. gravel blanket. Riprap will also be placed on the downstream face of the dam across the river channel. The reservoir behind the diversion dam is 6 miles long and about one mile wide. At the spillway level the reservoir will have a storage capacity of 45,000 acre-feet and will cover 3,000 acres of land.

Distribution System—The distribution system will consist of three main canals. The 34-mile South Side Canal carrying 1,000 sec.-ft. begins at the south end of the diversion dam and follows along the south side of the Wichita River valley to just above Wichita Falls. Water from this canal will be used both to irrigate 30,000 acres and to feed water into Lake Wichita which is the present source of water supply for Wichita Falls. Lake Wichita is 6 miles from Wichita Falls, whose rapid increase in population from 16,000 in 1918 to 42,000 in 1922 has made necessary the additional supply. The North Side Canal will branch from the South Side Canal 15 miles below the diversion dam and will cross the Wichita River valley to irrigate 85,000 acres on the north side. The Halliday Creek Canal will also branch from the South Side Canal and irrigate 45,000 acres of land southeast of Wichita Falls.

R. A. Thompson is chief engineer for the district and in direct charge of the work. O. N. Floyd is assistant chief engineer. The Morgan Engineering Company is consulting engineer, L. L. Hidinger, president of the company, giving immediate supervision to the work The general contractor for the project is the Callahan Construction Co., Dallas, Tex.

Extending London "Tube" Railway

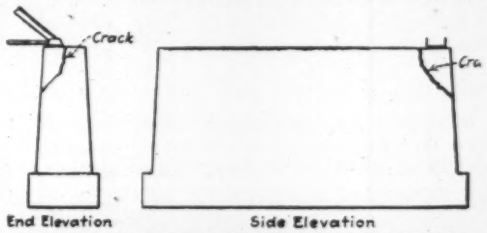
A six-mile extension is proposed for the City & South London Ry., the first line of the large system of deep-level electrically operated "tube" railways in London, England. These lines are distinct from the so-called "underground railways," which are near the surface. This extension from the present southern terminal at Clapham will connect with the newly authorized suburban line of the Wimbledon & Sutton Railway. Five miles would be in tunnel and it is stated that the work would afford employment for 20,000 men for two years. The cost is estimated at $5,930,000 for construction and $6,920,000 for equipment. According to the president of the company the tube lines did not serve the public to advantage until they began to extend beyond the business district. A great increase in passenger traffic is expected from extension into suburban territory. On the existing line, 7½ miles long, the tunnels are being enlarged to accommodate the rolling stock of other "tube" railways. This alteration was planned originally to be carried out without stopping traffic, work being prosecuted only at night and trains running through the shields. Owing to some slips and an inrush of water at one point it is stated that part of the line has been closed to traffic, arrangements being made to have tickets honored by bus and other surface lines between certain stations.

Repair of Defective Bridge Piers Cracked by Expansion

By Landon G. Smith
Bridge Engineer, Alabama Highway Department, Montgomery

A COUNTY bridge built in Alabama last year shows instructive results of bad design and construction. Soon after completion it developed such dangerous symptoms that the writer was requested to inspect the bridge and make recommendations for its repair. This county employs an engineer regularly to handle its road and bridge construction and this particular bridge was under his supervision, but I cannot say whether he or the company which fabricated the steel made the design.

The structure consists of six 50-ft. pony-truss steel spans with concrete floor, on five concrete piers and two concrete abutments. On the downstream side, pier 2 is cracked under both shoes, pier 3 cracked under one shoe, and pier 5 cracked under one shoe. On the up-



TYPICAL CRACKING OF PIERS UNDER SHOES

stream end pier 2 is cracked under one shoe, and pier 4 is cracked under one shoe (numbering is from the north). These cracks are in various stages of development, one especially having reached such a condition as to endanger the truss on that side, extending from the center of the pier downwards and outwards to the face about 8 ft. below the bridge seat. A sketch of a typical crack is shown.

The concrete is of very poor quality and poor finish, can be dislodged with a small hammer and crumbles readily. No good samples of the aggregates used were available, but a small quantity of sand which was said to be from the storage pile was found quite dirty, and samples of the concrete broken from piers indicated that straw or grass was present in the aggregate.

A very serious defect is found in the method of seating the trusses. No masonry plates are provided, the shoes resting directly on the masonry, which in any case would offer so much resistance to the movement of the trusses from expansion and contraction as to set up very high stresses in the concrete piers directly under the seats, especially as the top of the piers were left rather rough. Such construction, with the shoes anchored with two bolts in each, would be a large contributing cause to failure of the piers from cracking off under the bridge seats.

The following method of repair was recommended: (1) Incase the present piers in a sheathing of 1: 2: 4 concrete at least 8 in. thick, extending from the projection of the footings to tops of piers. In this casing place ¾-in. rods horizontally 18 in. apart. Pour new coping 18 in. thick reinforced with ½-in. rods 6 in. on centers placed across the narrow portion of the piers, and 2 in. above the present top of piers. (2) Set masonry plates of proper design to take care of expansion and contraction on the new coping and anchored thereto.

An Interview:

With W. W. FISHER
Division Engineer, Department of Highways, Cincinnati, Ohio.

and

JOSEPH GRADISON
Gradison Construction Co., General Contractors, Cincinnati, Ohio.

Winter Construction of Concrete Roads

By C. S. HILL
Associate Editor, Engineering News-Record

Advantage to the Contractor Important, and Careful Tests Indicate that The Engineer Loses Nothing in Strength and Finish of his Pavement

THERE IS no fund of experience in winter construction of concrete roads. The operation has been attempted only a few times. Perhaps no contractor has undertaken it more than once. Any conclusions that any one can draw from his own knowledge are, therefore, individual and must be held open to revision as evidence accumulates. It can be said, however, of the specific operation of which the following experience is related, that it is one of the most extensive and most seriously considered winter road jobs ever completed and indicates several conclusions with considerable certainty.

The operation consisted of improving with plain concrete pavement the Cincinnati-Brockville road for a distance of 4.7 miles. The pavement was 20 ft. wide with an 8½—10½—8½-in. section. All curves were super-

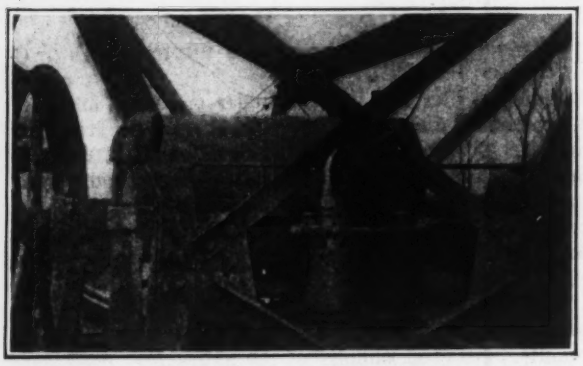


FIG. 1—OIL BURNERS HEAT CONCRETE IN MIXER

elevated and all sharper than 5 deg. were widened. In every respect a high-class structure was the object. The winter season in Southern Ohio lasts about four months, from November to April. On Nov. 24 the work was ordered suspended, as the specifications direct, on account of cold weather, at which time 1.2 miles or approximately 13,500 sq.yd. of concrete pavement remained to be placed. The contractor immediately applied for special permission to continue the laying of pavement, which was granted according to the specifications, with the additional stipulation that no concreting could be done at temperatures below 26 deg. F.

The Ohio specifications recognize weather as an element by the following clauses:

Suspension of Work: For such period as is necessary or during such time as the weather is unsuitable for doing the work the Director may suspend the work at places or altogether, if in his opinion public need requires it. Upon any stoppage of the work, all material shall be safely placed so as not to obstruct or impede travel on the right-of-way.

Protection from Freezing: No concrete shall be mixed or placed during freezing temperature except by SPECIAL PERMISSION of the Director. If at any time during the progress of the work the temperatures drop below forty degrees F., the water and aggregates shall be heated. Special precautions shall be taken to prevent all concrete from freezing after it is placed in position until the concrete has thoroughly hardened. Manure shall not be used as a protection for green concrete.

Any concrete showing injury by freezing shall be removed and replaced at the expense of the contractor. In no case shall concrete be deposited upon frozen subgrade.

Consideration of the operation takes two directions: (1) Contracting problems involved in performing the work, discussed by Mr. Gradison, and (2) the engineering results, from information given by Mr. Fisher.

Contracting Problems—When orders were received to discontinue work there was about one mile unfinished on the 5-mile contract section B and three miles unfinished on Section A, a 4-mile contract. The situation was as follows:

Section B was being constructed by a combination truck and industrial railway haulage plan, the sand and gravel being washed in the contractor's own pit, transported in batch boxes on trucks about three miles to an unloading station, where the boxes were transferred from trucks to cars, and then hauled by locomotives to the mixer. Section A was being constructed of materials delivered by railway, hauled to the job, dumped on the subgrade and fed to the mixer by wheelbarrows. About 10,000 bbl. of cement on hand were stored in different sheds along the road under construction and at the railway.

Confronting the contractor were two problems, if work were discontinued. The first was the storage and care of the cement to prevent deterioration. The second was the disruption of a skilled organization if the men operating the gravel plant, trucks, locomotives, pumps, tractors, and other machinery were laid off. These problems involved chiefly the work on Section B. At the time the order to discontinue was received work was proceeding on both sections. No effort was made to continue on Section A as only unskilled labor was involved, but, for the reasons indicated, permission was secured to continue Section B, and operations were actually resumed on Dec. 11, after 16 days' delay making ready for winter work.

In preparation for cold-weather operation the 2-in. water supply line was relaid with drain cocks at low points and covered in a trench averaging 2 ft. in depth. Two oil burners with flame projectors were installed above the mouth of a Koehring paving mixer so that the flame was projected directly into the drum. A coil in the radiator tank heated the mixing water. A four-burner (oil) asphalt heater was used to remove any frost observed and to dry the subgrade. Another portable heater was bought to thaw out batch boxes of sand and gravel which had stood over night. In the sand and gravel bins at the pit, steam jets were installed, taking steam from the boiler of the crusher which reduced oversize stones. The washed sand and gravel easily froze if it stood in bins and boxes.

To prevent frost action on the green pavement and on the subgrade they were covered. For the concrete slab peaked frames 10x23 ft. were built of light timbers and covered with tarpaulins. When placed over the slab, lanterns and oil lamps were hung under the tarpaulin, their number depending on the expected temperature. The frames and lanterns were kept in place 48 hours unless before the expiration of that time the temperature rose above freezing, and then the frames were taken off and moved ahead and the slab was covered with 4 to 6 in. of straw. There were enough frames and tarpaulins to cover 250 lin.ft. To protect the subgrade it was covered with 6 in. of straw for 250 to 350 ft. ahead.

Briefly the cold-weather operations led to the following observations:

1. It was necessary to wash every day the gravel for the day's work. As long as washing was continuous there was no trouble but if it was stopped for any time the pipes froze and had to be thawed.

2. The most difficult task was keeping up the water supply to the mixer. Constant attention was required. Pipes and pumps had to be drained every night and every morning the pumps had to be primed. With all this, quite often, low places had to be looked after where the accumulation of a little slush would stop the flow and the pipes would freeze.

3. The increased cost of operation was small except for the outlay for special equipment; the actual extra labor cost was small. In summer the slab has to be covered with burlap and sprinkled for 10 days, and the labor of covering to prevent freezing is no greater.

4. Labor for subgrading was increased very little because no attempt was made to subgrade when it was cold enough to freeze the ground under the covering.

5. The extra cost was for oil for heating the mixture and thawing the subgrade and this varied as the temperature conditions varied.

6. It was absolutely no trouble to keep the concrete from freezing after it was laid. Keeping frost from the raw materials was the greatest difficulty.

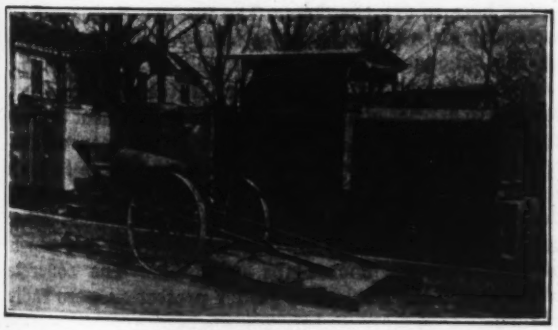


FIG. 2—OIL HEATER THAWS CRUST AND DRIES SUBGRADE

In general, the conclusion, quoting Mr. Gradison directly, is as follows:

"Our deductions are that winter work is not only advisable, but should be made compulsory. It helps the legitimate contractor to build up an organization of men who are skillful and able, and who, by knowing that they will have work all year round, will make contracting their profession. Usually, contractors' help is a floating help; men work for contractors when they cannot get anything else to do. By continuing work through the winter, it relieves the cement mills and gravel plants and railroad companies from the terrible burden they have to carry during the working season, which in our territory is limited to the period from May to November; the cement mills and the gravel plants, which have to distribute their 12 months' overhead over a production season of five months, should be able to sell their product cheaper; and the railroads

FIG. 3—TARPAULINS ON FRAMES COVER PAVEMENT

by having their equipment moved all year round should be able to derive the same revenue at cheaper freight rates. Of course, there is no question but that work during the winter is more expensive than during the summer, mostly on account of the shortage of daylight; on the other hand, labor is easier to get."

Engineering Results—During the period from Dec. 11, 1922, to March 10, 1923, inclusive, concrete pavement was laid on 34 days as follows: 4 days in December, 22 days in January, 4 days in February and 4 days in March. A total of 4,587 ft., or about 10,547 sq.yd. was laid, averaging 134.9 ft. or 310.2 sq.yd. per working day. Tests made on 6x12-in. cylinders of the same concrete cured under the same conditions as was the pavement showed the following compressive strengths:

Date Made	Days' Old	Total Load	Lb. per Sq.In.
1- 3-23	21	150,100	5,300
1- 3-23	28	146,900	5,200
1-19-23	14	90,500	3,200
1-19-23	28	96,600	3,420
1-26-23	21	103,300	3,660
1-26-23	28	107,600	3,800
3- 9-23	28	140,700	4,980
3- 9-23	28	152,600	5,400
3- 9-23	8	55,700	1,970

From an engineering standpoint, Mr. Fisher observes that conclusions on winter construction of concrete roads must necessarily be general and open to revision when based on the limited amount of pavement laid during the past three months. The results obtained, however, indicate that the quality of concrete and finish compare favorably with summer work.

In the work described, it was possible to carry on subgrade since the old macadam road was used as a base after scarifying, spreading the stone to full width of new concrete, and rolling. The preparation of an earth subgrade would have been impossible. Only by anticipating winter work and preparing and protecting from freezing a long stretch of subgrade ahead could concreting proceed on an earth subgrade; and even then difficulty would be encountered in the final rolling necessary to compact the inevitable rutting of subgrade far ahead of the mixer. A specified stone or gravel subgrade would necessarily increase the cost of road construction.

The economies of winter concreting involve, of course, a comparative study of summer and winter costs, and public convenience, in addition to careful and extensive tests of construction methods and the quality of work obtained. Present practice has established that the best results in construction, economy and public convenience are obtained by completing contracts before winter. How better progress can be obtained during the usual construction period is a question for authorities letting road contracts; possibly allowing estimates on stated lengths of completed pavement or a bonus and penalty clause in contract might tend to speed up the completion of contracts.

The next article in this series will appear in an early issue.—EDITOR.

Fires in Formwork in Concrete Buildings

TWO FIRES in formwork of concrete buildings under construction occurred within three days of each other last January and have been reported recently. The first, on Jan. 4, was in the McDougall terminal warehouse at Duluth and the second, on Jan. 7, in the James Butler warehouse at Long Island City, N. Y.

The Duluth building is to be 488 ft. long and 130 ft. wide and was five stories high at the south end and four stories high at the rest of the building at the time of the fire. It is of a flat-slab reinforced-concrete type, floor slabs 9 to 10 in. thick, roof 6 in., all reinforced by ⅜-in. and ½-in. steel rods. The columns are 22 to 30 in. in diameter, reinforced with four to eight ¾- and 1-in. straight rods and ⅜-in. spiral reinforcement. The concrete was one part cement, two parts lake sand, and four parts gravel for the slabs, and for the columns a 1:2:3 mixture of the same material. The first floor was completed in October, the second and third in November, and the fourth during December, with the exception of the north end of the fourth floor which was completed the day before the fire.

The floor form boards and struts had been removed from the first and second floors, but at the time of the fire were still in place on the third, fourth and fifth floors. These forms were made of ⅞-in. lumber, surfaced on one side and two edges. The struts were 4 x 4-in. rough sticks, set 4 ft. on the centers throughout the third, fourth and fifth floors, there being about 1,000,000 b.ft. in all the building. The fourth and fifth floors were covered with 3-in. shavings and these floors were heated with salamanders burning hard coal, coke being unobtainable. The third, fourth and fifth floors were inclosed with heavy canvas curtains. There were no division walls and, with the exception of the curtains inclosing certain floors, the building was entirely open.

On Jan. 4 there was a temperature of about 30 deg. above zero and a northwest wind of 10 to 12 miles an hour. The fire was discovered at 5.15 p.m. after most of the men had left. It was at the north end of the third floor in the canvas curtains and presumably originated from one of the salamanders. An alarm was immediately turned in but the fire spread so rapidly that within 15 min. the entire fourth and fifth floors were ablaze and the three men who were in the building had difficulty in getting out. The fire burned rapidly and fiercely for some 20 min. and continued for about 1½ hr. before it was under control. Notwithstanding the fact that the building was accessible on all sides, the fire department had little chance to be of value except to save exterior framework, the concreting tower and the derricks. The fire was in the falsework and in the shaving protection of the floors.

As the struts burned and fell, the ends of the floor forms dropped down allowing the fire to get in between the floor forms and the concrete, completely destroying the lumber and heavily damaging the slabs. The outer coverings on all columns, on the fourth and fifth floors and part of the third floor, was cracked and disintegrated and the cores inside the spiral reinforcement were in some places damaged beyond repair. The fourth and fifth floor slabs were badly chipped and cracked on the under surface, making necessary replacement of a large part, and the outside columns on the west side of the third, fourth and fifth floors were badly chipped and cracked. The fourth floor at the north end of the building was finished the day before the fire and completely collapsed. The total loss was figured at from $175,000 to $200,000.

The fire in this building is described in the *Quarterly* of the National Fire Protection Association for April, 1923, and also by A. R. Lord in the *Proceedings* of the American Concrete Institute, Vol. 19, 1923.

The James Butler Fire—The James Butler Grocery warehouse in Long Island City is to be a six-story reinforced-concrete warehouse. The floors were also of the flat-slab type. At the time of the fire all the slabs on the first and second floors had been poured with the exception of 25 per cent of the second floor at the southwest corner. Struts and forms for the unfinished part were not up, but forms for about 10 per cent of the third floor were in place near the northeast corner. None of the slabs on the third floor had been poured. There were thirty open coke-fuel furnaces used as salamanders to prevent fresh concrete from freezing.

The fire originated in a canvas curtain on the first floor at the northwest section of the building, either from a flying spark or from contact with a salamander. A space 100 by 120 feet at the northerly end was curtained off by canvas and the thirty salamanders were in use here to dry the floor. The fire was discovered by a watchman who had shortly before placed fresh coke on the salamanders. He attempted to extinguish the burning canvas while another watchman blew his whistle to attract attention. The fire department arrived soon thereafter, but by that time all the canvas curtains on the first floor were ignited and these in turn set fire to the wooden forms for the second and third floor concrete arches. All of these forms were either completely burned or badly damaged and five half panels of new concrete floor slabs collapsed. The concrete columns and the steel plate girder protection were badly spalled.

In the conclusions regarding these fires, the *Quarterly* of the National Fire Protection Association states that they illustrate the importance of the fire hazard involved in the construction of concrete buildings due to (1) the large amount of lumber for construction of the wooden forms for floor arches, columns, and walls, and (2) the high fire hazard resulting from the use of numerous salamanders or similar furnaces for heating large areas in order to make it possible to pour the concrete during freezing weather. The canvas curtains for inclosing the heated area act as effective kindling material to ignite lumber contained in the wooden forms.

Experience with Activated-Sludge Plant at Eldorado, Kan.

After Oil Boom Septic Tank and Chlorination Plant Changed to Activated Sludge—New City Managers Practice False Economy

BY ALBERT H. JEWELL
Chief Engineer, Kansas State Board of Health, Lawrence, Kansas

In his letter transmitting this article Mr. Jewell says, "I heartily endorse the editorial, 'No Royal Road to Sewage Treatment,' in your issue of April 5, 1923, p. 609. The situation at Eldorado illustrates the point of the editorial. There is no one set system to be used in all cases and in most cases individuality will have to be expressed by the engineer using such combinations of sewage treatment as are needed to accomplish the end in view."—EDITOR.

WHEN OIL was found in Butler County, Kansas, in 1915, Eldorado, the county seat, had a population of 2,705. In 1918 the population had increased to 16,246. It is obvious that the water and sewerage systems were entirely inadequate. On account of the town's mushroom growth, it was not plain whether improvements of a temporary or a permanent nature should be made. Sewage had been disposed of by means of two septic tanks each 18 ft. wide and 58 ft. long, having an average depth of 8 ft. The effluent from the tanks was chlorinated in a mixing chamber having a detention period of about a half-hour. The effluent was discharged into the Walnut River, which is used as a source of water supply by the town of Augusta, fifteen miles downstream, and later Douglass.

Change to Activation — Preliminary investigations showed that if secondary treatment were to be employed the sewage would have to be pumped and that there was a limited area which could be used for secondary treatment. An estimate of tank treatment with sprinkling filters was $125,000. Activated sludge was investigated by Bert Wells, city manager, and C. A. Haskins, then engineer for the Kansas State Board of Health. They received valuable help from sewerage commissioners of Chicago and Milwaukee as well as several consulting engineers. An estimate of the cost of remodeling one of the septic tanks into an activated-sludge plant and of constructing two settling basins was about $20,000, the difference between a sprinkling filter installation and the activated-sludge plant being about $105,000. Interest at five per cent on this difference would give $5,000 per year to take care of the higher operating cost of the activated-sludge plant. In the estimates it was considered that in either case two men would be required at an expense of not less than $2,400 per year. Power for the sprinkling filter plant would be $1,500 per year and for the activated sludge plant $3,000 per year. Taking all of these conditions into consideration, with special emphasis on the fact that it was a mushroom growth with a probability of decrease in population after the oil boom, it was decided that the activated-sludge plant with its lower initial cost would be the best adapted for these conditions.

One septic tank was therefore converted into an aeration tank by deepening it to 15 ft. and installing 216 filtros plates, making a ratio of the plates to the surface of the tank of 1 to 4.8. Two Nash Hytor compressors with a capacity of 500 min.-ft. supply air to the sewage at the rate of 1.25 cu.ft. per gallon of sewage. The old mixing and sterilizing chamber was deepened and made into two sedimentation tanks of the inverted pyramid type, the inlet being submerged and the outlet taken off over a rectangular weir on the opposite side. A small Johnson press was installed to take care of sludge. The remodeling cost was $15,600.

Unfortunately the city manager resigned shortly after the plant was placed in operation. Since that time there have been three city managers, none of whom had had any former experience with activated sludge, and in an attempt to cut down operating expenses some difficulties were encountered. An attempt was made to operate the plant on two 8-hr. shifts. This resulted in losing the activation and also clogging the filter plates, as well as loosening and blowing out some of these plates. Since placing the plant on 24-hr. operation, there has been no difficulty with the aeration tank.

Further Changes—It was soon found that the sedimentation tanks were not large enough to take care of the peak loads, so a third tank was built the year following the completion of the plant and this past year it was found necessary to build a fourth tank.

The Johnson sludge press was found to be very unsatisfactory and the city has never been able to make use of it. The sludge has been pumped to a nearby draw but undoubtedly in the future some better method of disposal will be adopted.

An effort has been made to increase the efficiency of the sedimentation basins by constructing baffles, but the velocity is so great at peak loads that sludge is carried out in the effluent. The effluent is now taken off at the center of each tank by means of rectangular wooden troughs. Experience with a Dortmund tank is contemplated to try to increase sedimentation.

It is interesting to note that the quantity of sewage has increased with the decrease in population. The 1920 census gives Eldorado a population of 10,995. This is accounted for by the fact that a good many of the boom shacks did not have sewer connections. The people who remained after the boom have built modern homes so that there has been a gradual increase in sewer connections.

Cost—Records kept by the city managers show the following cost of operation and addition to capital investment:

Operation	1921	1922
Salaries	$3,142	$2,835
Power	2,003	3,900
Miscellaneous	426	
	$5,571	$6,735
Construction cost of additional sedimentation tanks	$3,370	$865

The writer is indebted to E. H. Hawkins, formerly city manager of Eldorado, for much of the foregoing information.

Provisional Census Mortality Figures: 1922

Slightly higher mortality rates in 1922 than those for 1921 are shown by provisional figures announced by the Bureau of the Census. The 1922 rate for the 33 states in the death registration was 11.9 against 11.6 in 1921. Maine stood highest in 1922 with a death rate of 14.7 per 1,000, and Idaho was lowest with a rate of 8.1. The provisional birth rate for the 24 states in the birth registration area was lower for 1922 than for 1921, the figures being 22.7 against 24.4, the highest 1922 rate being 30.2 for North Carolina against 18 for Washington.

Philadelphia Trainshed Wrecked by Fire

Wood Decking of Track Floor and Combustible Roof Sheathing Allow Fire to Spread—Early Development Favored by Concealed Spaces Between Track Floor and Ceilings Below

FIRE which started under the track floor of the Broad St. station trainshed of the Pennsylvania R.R. at Philadelphia just before midnight on Sunday June 10, wrecked the entire track floor and the huge trainshed and destroyed a large amount of baggage and railway property in the story below the track floor, including the power plant, which supplied heat and power to the station building. The terminal and office building, lying east of the trainshed, was not injured. The size and rapid spread of the fire resulted from the antiquated construction of the station, built partly in 1881 and partly in 1893.

Wooden framing and decking covered with a waterproofing layer formed the track floor, being supported by a system of steel columns, floorbeams and stringers. Below the supporting steelwork were metal ceilings supported by wood framing, to cover the rooms below, which housed record storage, baggage and mail and other railroad facilities, besides the power plant. Fire started in the space between floor and ceiling, according to present evidence, and got a thorough start by spreading in the long continuous open spaces under the track floor, where woodwork was exposed everywhere. The actual origin of the fire is not known, but electric wires have so far been charged with the responsibility. When the fire was first noticed it was breaking through the floor of one of the platforms between tracks, but at this time it had already grown to such size below the floor that it could not be controlled.

The entire track floor, including the platforms and their supports and the wooden track supports, burned, and the flames soon ignited the wood sheathing and roofing of the trainshed above, consuming all this combustible material, and injuring the ironwork of the roof extensively. Below the track floor, the contents of the ground-floor rooms were burned out and the ironwork of the floor was extensively wrecked. Several of the trains in the trainshed at the time of the fire could not be pulled out soon enough and were destroyed.

A narrow strip of the outer or westerly end of the trainshed did not have the floor construction described, but was of earth fill on masonry arches. The damage here was only that due to the transmitted heat and to the fire of the trainshed sheathing above.

Wind conditions were not particularly bad at the time of the fire, but the great area covered and the large amount of combustibles in the construction made the fire hot and refractory, so that it required nearly

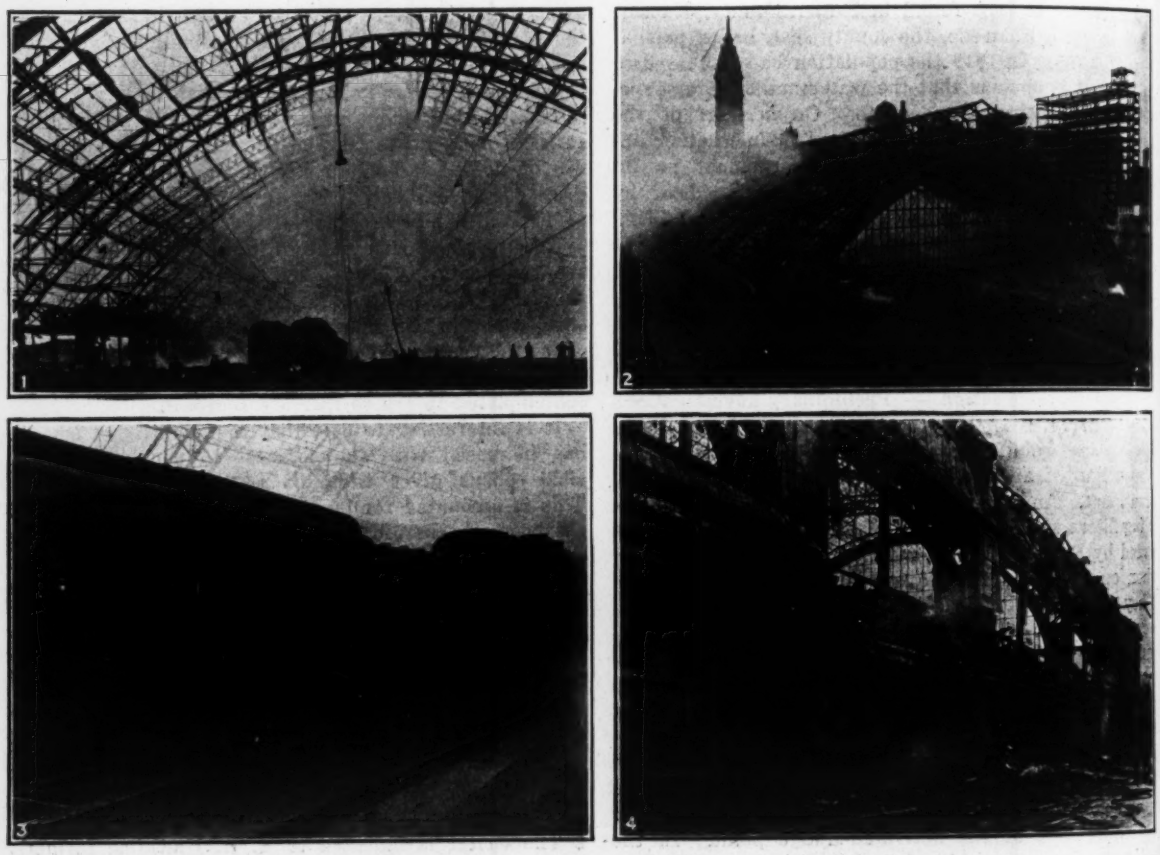


FIG. 1—PENNSYLVANIA R.R.'S PHILADELPHIA TRAINSHED FIRE

As it appeared Monday, June 11, before fire was fully extinguished. Roof sheathing burned away. Main arches of roof are in good condition, but minor steel framing is extensively distorted. Lower view shows part of a train that was caught in the fire; the track rails were left without support after the wood upper framing of the floor burned.

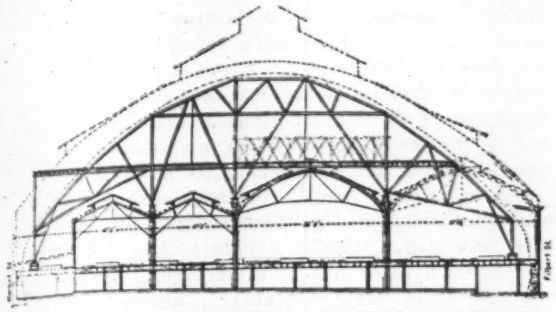


FIG. 2—CONSTRUCTION OF TRAIN SHED IN 1893, SHOWING EARLIER FOUR-SPAN SHED AND ERECTION TRAVELER

two days to extinguish. Practically no damage was done to buildings outside the station area, however, although the station is in the heart of the business district and only a stone's throw away from the City Hall with its prominent tower.

In the wrought-iron framing of the trainshed roof, practically all the minor members are bent, buckled, or sagged as a result of the heat, while the arches themselves show no injury. No detail examination was possible up to the time of writing, but there is no appearance that either the arches or their tie rods (in the floor) were seriously enough affected to make them unfit for further use. However, as soon as the extent of injury to the roof framing as a whole was apparent, it was decided to take down the trainshed roof and construct umbrella-shed shelters over the new platforms pending the reconstruction of the terminal. A contract for taking down the shed has been awarded to Henry Hitner & Sons.

With the central point of the Pennsylvania System out of service through the fire, work to restore traffic was taken in hand immediately and with admirable energy. New signaling and dispatching wire lines were run outside the trainshed even while the fire was still in progress, the West Philadelphia and North Philadelphia stations were made terminal points, and crews started to repair overhead conductor wires at the west end of the station to permit electric traffic to be resumed at the earliest moment, using the platform extensions and sheds outside the main shed. By Tuesday morning, 30 hr. after the outbreak of the fire, work was actively in progress building new platforms on the wrecked steelwork of the trainshed floor, and as the views herewith show, by the following morning several of these platforms were in service. Before this, stairs had been built for direct access from the street level to the surviving platform extensions west of the shed, and these went into service even on Monday. A brief summary of events as related to traffic is as follows:

At 11:45 p.m., June 10, when the fire was discovered, the entire station traffic of 529 trains daily was paralyzed. By 5 a.m., Monday, arrangements had been made for trains to terminate at North Philadelphia, West Philadelphia, 31st and Chestnut Sts., and (for the Atlantic City trains) Camden, abandoning bridge train service from the coast. Conductor-wire reconstruction was so rapid that before four o'clock Monday afternoon electric service was resumed from the west end of the station shed to Paoli and Chestnut Hill, this service being made complete by midnight. By Thursday, June 14, normal steam-train service on two branches was resumed from Broad St. station, and bridge train service was resumed, terminating at West Philadelphia. Within 72 hr. after the discovery of the fire, 246 trains, or nearly half the total, had been restored and nine of the sixteen tracks were available.

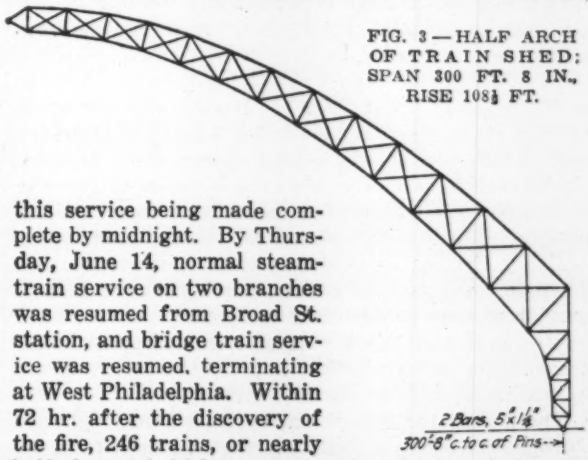


FIG. 3—HALF ARCH OF TRAIN SHED; SPAN 300 FT. 8 IN., RISE 108½ FT.

Broad Street station trainshed was among the three or four largest steel arch roofs in existence; at the time it was built, thirty years ago, it was the largest. It was 300 ft. 8 in. in span, c. to c. end pins, with a rise of 108½ ft. c. to c., and was 598 ft. long. The arches were in pairs, forming ten towers 9 ft. wide, 56 to 67 ft. apart. The material was wrought-iron. The tie bars between the arch shoes, however, were of steel. When the shed was erected the track floor and its supports were left unchanged, except for some lateral extension. This lower construction dated from 1881. (See *Engineering News*, June 1, 1893, p. 507.)

FIG. 4—RESTORING TRAFFIC IN BROAD ST. STATION AFTER THE FIRE
Platform construction and removal of wrecked cars in progress. Several platforms already in service June 13.

Cost of Detours in Constructing Wisconsin Roads

Cost to Traveling Public Based on Records for 1922 Estimated at About $1000 per Mile Under Construction

By N. M. Isabella
Assistant Maintenance Engineer, Wisconsin Highway Commission, Madison, Wis.

WISCONSIN had upwards of 300 road construction operations under way at one time on its state trunk highways during the season of 1922. The majority of these were improvements where traffic could be maintained over the regular route with a fair degree of comfort, but there were also many, such as concrete road construction, large bridges, heavy grading in clay and very sandy soils, which necessitated detours properly to care for traffic.

The construction season usually opens about April 1, and extends to about Dec. 1. During this period in 1922 there were approximately 3,000 miles of highways actually affected by some type of construction. In practically every case involving an improvement of concrete or similar type pavement, a detour was necessary. In many cases detours follow secondary roads, which, under ordinary circumstances, do not carry much traffic, and when the through travel of the trunk highway is directed over them, they become very badly worn. It is rather expensive to maintain a road of this kind under heavy travel. The detour further imposes the inconvenience of additional mileage on the traveler.

There were 159 detours on the state trunk highways during the season of 1922, varying in length from 0.5 mile to 20 miles. The shortest time a detour was in use was seven days. The longest period a detour was in service was 220 days. In many cases the detours did not cause any additional mileage for the traveler. In a few cases they were actually shorter than the regular route. In the great majority of cases, however, the detour was considerably longer than the section of the regular road under construction, thus causing the traveler to make extra mileage.

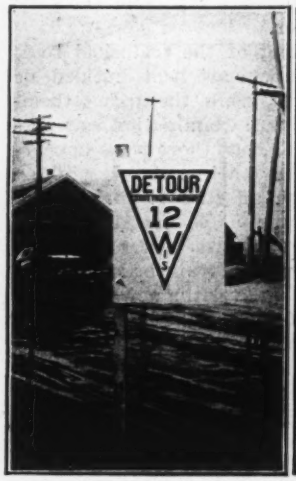
Analyzing the situation of 1922, we find that, of the 159 detours, three were shorter than the regular route, 13 caused no additional mileage, and 143 caused increase in mileage for the traveler, varying from 0.5 mile to 12 miles.

The increase in mileage due to the 159 detours was 342 miles, or an average of 2.15 miles per detour. The total number of days that the 159 detours were in service was 12,977, or an average of 81.6 days for each detour. From traffic counts taken at over 100 representative stations, it was found that the average number of vehicles per day passing a given station, and likewise over a majority of the detours, was 1,320. In practically all cases the traffic stations were so situated as to be in close proximity to the various detours. In many cases a single traffic station furnished proper counts for several detours that were immediately adjacent. Thus, due to the fact that most detours were in the heavily traveled communities, it is believed that the figures given above on traffic are fair from the standpoint of average conditions, and if anything, conservative.

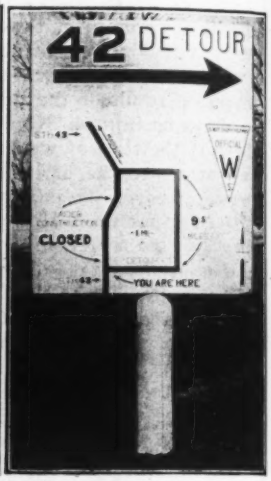
As stated previously, the great majority of these detours existed in the well settled and thickly populated sections of the state, where the traffic is more concentrated than in other sections, and the tonnage hauled per mile is much greater. If we disregard the additional cost of maintenance, marking and signing of the detours, also the loss of time, and analyze the extra cost to the traveling public for the operation of their motor vehicles only, we would have as follows:

Let us assume that the average cost per mile for operating all types of motor vehicles is 10c. We would then have $2.15 \times 12{,}977 \times 1320 \times \$.10 = \$3{,}680{,}000$, for the total extra cost to the traveling public excluding the items mentioned above. Reduced to a daily basis, this would mean approximately $45,000 per day.

At first sight it would appear that this is a considerable loss to the traveling public that seemingly is not justified. There are several angles from which we might discuss this. Probably some of the best methods



MARKERS ALONG ROUTE OF DETOUR



DETOUR MAP PLACED AT ENDS OF DETOUR

of reducing this penalty imposed upon the traveling public would be (1) the early letting of contracts to contractors who possess the proper equipment and ability to speed up construction and thus shorten the time all detours are in service; (2) the storing of enough materials to keep construction in continuous operation over any period of poor transportation service on the railroads; (3) getting legislation that would permit the concentration of work on through highways and thus not have the same road closed year after year for several jobs; (4) shortening the period in which concrete road is allowed to cure, by use of a cement that will set and cure in a few days after it has been laid. It is general practice now to allow about 14 days for a concrete road to cure. Cutting this down several days would affect a material saving to the traveling public.

As stated before, 81.6 was the number of days that the average detour was in service. It can readily be seen that if this figure could be cut down to say 70 days, there would be effected a reduction in cost to the traveling public on the total detours $11.6 \times 1320 \times 159 \times \$.10 \times 2.15 = \$524{,}000$. There are limitations, however, to the number of days that can be cut off, even if the most modern methods are employed.

There are advantages that accrue to the traveler in the future in the use of the completed highway, even

with this temporary loss. There is no question but what the cost of operation of a motor vehicle on the new highway would be decidedly less than that on the old highway, were it to be used indefinitely. This, of course, would, over a short period, offset the cost and the inconveniences caused by the detour. However, this does not excuse those in charge of highway construction from trying to reduce the inconvenience and additional cost due to the detour. Work should be planned well in advance and contracts let early enough so that at least the shorter jobs may be completed before heavy travel commences.

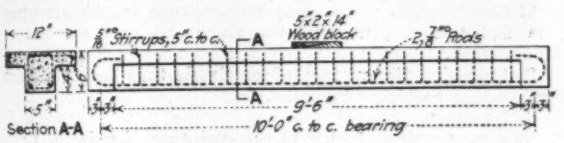
Test Two Beams To Determine Strength of Light-Weight Aggregate

By B. S. Myers
Chief Engineer, Capitol Steel & Iron Co., Oklahoma City, Okla.

On account of the proposal to use concrete made with the light-weight aggregate Kansas Haydite in several important buildings in this city, it was decided to make a comparative test, using Haydite in one case, and rock and sand, obtainable in the locality, in the other.

The quantity of the Haydite available for this test was very limited, and the size of the test beams was restricted accordingly. The Haydite used was obtained from a local contractor who had been furnished samples of the material from regular stock of the Haydite Co. of Kansas City, Mo.

The drawing shows the form and dimensions of the test beams, also the reinforcement used. The test beams were reinforced sufficiently to guarantee failure



DETAILS OF THE BEAMS

in the concrete in compression. In both cases the concrete was proportioned carefully by volume, a 1:2:4 mixture being used with a minimum amount of water.

After the beams were poured, they were placed in a room in which the temperature was kept at about 70 deg. day and night until the test was made on the tenth day. The test specimens were covered with sand and kept well wet down.

The table shows the theoretical stresses on the steel and the concrete and the deflection of the beam 7 in. from the center line for the loads indicated.

The beam made of rock and sand concrete required a load of 7,300 lb. to cause failure, at which time the concrete was stressed to 3,112 lb. per sq.in. The concrete in this beam was very dense, and the beam had a smooth, neat appearance when the forms were removed. When the forms were removed from the Haydite beam, the concrete appeared to be quite porous and of not as good a quality as the other beam.

About twenty-five engineers and architects witnessed the test, and it was their unanimous opinion that the Haydite beam would fail under a considerably less load than the rock and sand concrete beam. However, a load of 8,000 lb. was required to cause failure, at which time the concrete was stressed to 3,400 lb. per sq.in. maximum. The Haydite concrete weighed 108 lb. and the rock and sand concrete 144 lb. per cu.ft.

Haydite is an artificial aggregate for concrete, made by burning clay or shale to a clinker in much the same way as the clinker is formed in the process of manufacturing cement. This clinker is crushed to the desired sizes required for the making of concrete. The above tests seem to indicate that the strength of the Haydite concrete is at least equal to that of ordinary concrete in cross-bending, and that Haydite concrete would be satisfactory for ordinary concrete construction.

STRESSES AND DEFLECTIONS IN TEST OF LIGHT-WEIGHT AGGREGATE

Load, Pounds	Stress, Lb. per Sq.In. Steel	Conc.	Deflection Stone and Sand, In.	Haydite
1,000	6,000	425	0.11	0.13
2,000	12,000	850	0.21	0.24
3,000	18,000	1,275	0.32	0.36
4,000	24,000	1,700	0.44	0.48
5,000	30,000	2,125	0.59	0.61
6,000	36,000	2,550	0.75	0.75
7,000	42,000	2,975	1.02	0.93
7,300	43,800	3,112	....	
8,000	48,000	3,400	....	1.60

New Stresses for Fir and Southern Pine Deduced From Tests

An extended series of comparative tests of Douglas fir and southern pine, both long leaf and short leaf, has been carried on during the past two years by an expert committee appointed by the New York Lumber Trade Association. High strength values were found for all species. The following figures represent the averages for modulus of rupture (minimum and maximum values in parentheses): Douglas fir, small specimens, 8,925 (4,730-12,300), large timbers, 6,125 (3,970-9,655); longleaf pine, small specimens, 9,585 (6,580-12,820), large timbers, 6,940 (4,810-9,110); shortleaf, small specimens, 8,140 (6,840-9,230), large timbers, 5,870 (4,320-7,520). The elastic limit generally was about two-thirds the modulus of rupture. These timbers were of the following grades: Douglas fir, No. 1 common; longleaf pine, merchantable grade, 1905 interstate rules; shortleaf, 1910 specifications. It is reported that the tests on the small specimens show that clear portions of equal density of the two species are of approximately equal strength, and that by proper grading rules it is possible to obtain structural Douglas fir timbers equal in bending strength to longleaf yellow pine, except that the shear values are proportional to the relative weights.

It was found, however, that a large proportion of the materials selected for test was of considerably higher grade than the minimum of the respective grade rules, and that several higher classes of material could readily be established. An additional grade of Douglas fir which came into the eastern market after the tests were begun gave occasion for a supplementary set of tests, showing for the large timbers an average modulus of rupture of 7,345 (6,170-8,340), with a large proportion of the new grade giving even much higher values.

On the basis of all the tests the investigators proposed that working stresses in bending be fixed at 1,600-1,800 lb. per square inch for southern pine and 1,350-1,800 lb. per square inch for Douglas fir, as follows: Longleaf yellow pine, 1905 merchantable, 1,600 lb. per square inch; select structural southern yellow pine, 1,800; No. 1 common Douglas fir, 1,350; structural grade Douglas fir, 1,600; dense structural grade Douglas fir, 1,800 lb. per square inch. The recommendation was approved by the New York Lumber Trade Association.

Nashville Concrete Bridges to Be Repaired

City Appropriates $300,000 to Remedy Deterioration on Sparkman St. and Jefferson St. Concrete Trusses

AS NOTED in *Engineering News-Record*, Dec. 8, 1921, p. 934, serious disintegration of the concrete in the Sparkman St. and Jefferson St. Cumberland River bridges at Nashville, Tenn., has been causing the city authorities concern for some years. Last year the city appointed the Freeland-Roberts Co., engineers of Nashville, to study the situation and report on proper remedies. The engineers have rendered a preliminary report, abstracted below. The Tennessee legislature has passed a special enabling act to allow the city to issue $300,000 in bonds without submitting them to referendum. As soon as these bonds have been sold plans and specifications for the repair work will be prepared.

The Freeland-Roberts report follows:

Both the Sparkman and Jefferson St. bridges consist of three steel truss spans across the river proper, reinforced-concrete viaduct approaches at each end and concrete on earth fill leading up to these viaduct approaches. No specifications covering the work could be found, but we have been informed that the concrete mix used was one part portland cement, two parts fine aggregate and four parts coarse aggregate.

The cement used was not tested by a commercial laboratory specializing in the testing of cement, but each car was tested by the consulting engineer in charge of the work. We have no data on hand to show the results of these tests nor the amount of cement actually used on the job. None of the original fine or coarse aggregate is available for testing, but the larger part of these came from a quarry located near Newsom Station and a small part came from a quarry at Carter's Creek. There is nothing to show that any provision was made to make the concrete waterproof.

Preliminary examinations were made of these structures prior to Dec. 18, 1922, after which date we began a comprehensive detailed examination of the structures. We have given them constant study and surveillance since that time.

We have made an examination of the plans and checked the design of the reinforced-concrete work and find that in all instances except one the stresses in the structure under an assumed loading do not exceed those recommended for safe engineering practice, and a sufficient amount of reinforcement has been used to safely carry the loads assumed. Safe engineering practice recommends that the shearing stress in concrete shall in no case exceed 120 lb. per square inch, but in the one exception, referred to above—viz., in the floor-beams, this limit has been exceeded.

Disintegration of the concrete is apparent in both structures, giving evidence of the failure of the concrete at such places as are exposed to the action of water and other weathering agents. The concrete at such points is badly disintegrated, the mortar neither adhering to itself nor to the coarse aggregate, but being apparently rotten. The steel at all such places is badly rusted and the mass of concrete seems to be slowly but surely going to pieces. The corners of the columns supporting the structure, in nearly all instances are spalling off, exposing the steel reinforcement underneath, and this steel is badly rusting. The floor-beams are as a rule in fair condition but there are instances where cracks have developed through them, evidencing their failure. Where these beams cantilever to carry the sidewalk beams and slabs, there are many instances of their failing in the cantilever portion. It appears on all floor-beams on which sliding plates rest that these plates have frozen together and the concrete beam has been severely damaged by the resulting pressure from expansion and contraction.

The longitudinal beams, under the roadway proper, are in better condition than almost any other part of the structures, but at every construction and expansion joint and at all other places where water has gone through the slab, and run down over these beams, the concrete has disintegrated and the steel reinforcement rusted. The floor slab, under the roadway proper is in a similar condition to the beams under this portion of the structure, disintegration of the concrete and rusting of the reinforcement having occurred at all places where the water has run on and into these surfaces. The beams under the sidewalk slab and the sidewalk slab itself are in much worse condition than any other portion of the structure. The slab has developed numerous cracks in every direction, allowing the water to get into the slab and filter through it onto the beams underneath, and at every one of these places the concrete has badly disintegrated and the reinforcement rusted.

The principal causes of the disintegration of the concrete are:

1. Disintegration of both fine and coarse aggregates under the action of water due to improper materials and limestone containing shale, rotten stone, etc.
2. Separation of parts of concrete mix when dropped into column forms.
3. Steel too close to surface of concrete.
4. Porous concrete which allows water to be absorbed, thus rusting the steel reinforcing and causing the concrete to be broken up when this water freezes.
5. The use of limestone dust which balls up in mixing and coats the coarse aggregate so that the mortar will not stick to these particles.
6. There also appears to have been a movement of the structure down the hill causing breaks in the tie beams between columns.
7. Construction joints and temperature cracks allowing the water to run through the slabs and onto the beams underneath.
8. Finishing the surface of handrails thus taking off the waterproof coating of mortar.
9. Laitance.

The most potent factor in the disintegration is the first, but all the others named are at work to more or less extent. The other causes contribute to the decay and disintegration of the aggregate by allowing more exposure, rusting of the steel reinforcing which breaks the adhesive bond between the steel and the concrete, alternate freezing and thawing of the water in the concrete breaking the bond in the concrete itself, and the gradual breaking down of the whole concrete mass due to the ever increasing exposure to the weather.

Disqualification from Holding Public Office

Massachusetts legislation against bribery and corruption of municipal officials has been amended by an act of the legislature just signed by the governor entitled "An Act Providing for the Removal of Mayors in Certain Instances." The original act provides that any public official convicted of bribery or corruption shall, besides being subject to fine and imprisonment, be disqualified from holding any public office thereafter. The amendment adds that "an executive, county other than judicial, or municipal officer who is finally convicted of the crime of larceny, embezzlement or obtaining money under false pretences committed in connection with the performance of the duties of such office shall, in addition to the penalty imposed by law for the punishment of such crime, forfeit his office and be forever disqualified to hold any public office, trust or appointment as aforesaid." A similar bill was rejected by the Massachusetts legislature in 1922 because it referred exclusively to the mayor of the city of Boston.

Economics of Railway Water-Supply Systems Reviewed

Relation to Train Service and Boilers—Results of Treatment — Problem in Efficiently Handling Many Small Plants

Abstract of a paper read before the Western Society of Engineers by C. H. Koyl, engineer of water service, Chicago, Milwaukee & St. Paul Ry.

ON ALL railroads there is constant study as to the expenditure which is justified for provision and maintenance of facilities for the hauling of trains, and the basis in each case is the determination of the number of train-minutes which that facility will save.

Cost of Train Delays—The average freight train costs about $1 per minute, of which the coal and the wages of the train and engine crews make 20c. Consider the case of a regular water station out of water for one day, due to the breakdown of a pump or pumping engine, the freezing of a river suction, the bursting of a pipe, or any other cause.

The damage is principally in the delay to trains and grows with the density of traffic. If the lack of water necessitates one engine cutting loose and running for water and thus causes one train to lose one hour, the immediate loss in coal and crew's wages is $12. If it delays ten trains one hour each, the immediate loss is $120; and if it should happen on a busy line with thirty trains per day, the immediate loss will be not merely $360 but probably three times that much from the tying up of traffic. The prevention of such losses depends on the vigilance of competent water-station attendants and on duplication of equipment at important places.

Location of Water Tanks—There is sometimes the mistake of placing the tank in a hollow or sag of grades because the creek is there. Engineers, I suppose, must bear the blame, for no operating man would do such a thing. It costs a little more to run the discharge pipe up the hill and to pump the water up the hill, but the extra cost is so small as compared with the continuous waste of money in starting heavy trains from the hollow that there is no justification for the practice.

Water-Car Service—On most railroads there are points, generally on branch lines, where a supply of 20,000 to 25,000 gal. is necessary because of the distance to the next station on each side, but where water is so difficult to get that an equipment to supply even 20,000 gal. per day would cost as much as a large main line water station. It may be decided, therefore, to run a water car on each freight train and sometimes an extra tender on each passenger train between the two nearest water stations on each side, say fifty miles apart. The cost of operating these water cars is usually small but I have found water car cost for a northern branch line as high as $800 per month in winter.

Chemical Treatment of Water—On the subject of quality of water there is less knowledge, but our experience is growing rapidly. A water-treating plant for a railroad must be capable of cleaning muddy or slimy water, softening hard water, neutralizing acid water and delivering to the tank clean soft water whose only variable from one station to another is the amount of sodium sulphate or sodium chloride in solution. Several railroads have one or more engine districts completely fitted with water-treatment plants.

Examples of Water Treatment—On the Great Northern Ry., in 1914, we put a water-treating plant at every water station on the Montana main line for a distance of 420 miles. As February is the hardest month for railroading in that part of the country, we made a careful comparison for that month. In February, 1914, the average load per train was 1,364 gross tons, and in February, 1915, it was 1,881 tons, an increase of 38 per cent; and the average running time over a division (including delays) had been cut down from 14 to 10 hours. The result showed an increase from 100 to 193 ton-miles in one year for the same engines.

Although I was not able to compute the exact total value of the improvement in service, my best estimate was a saving of $1,000 per mile of road per year where there was an average of ten trains per day. That this is not too high an estimate is indicated by the fact that in 1908 the El Paso & Southwestern Ry. abandoned deep-wells along 128 miles and supplied mountain water through a pipe line of 120 miles, built at a cost of $700,000. The chief engineer reports that in less than two years the pipe line was paid for by savings of $2,700 per mile per year.

On the Chicago, Milwaukee & St. Paul Ry., we began in 1920 the installation of water-treatment plants on the lines east, west and south of Mitchell, S. D., where the water is very bad (see *Engineering News-Record*, Oct. 5, 1922, p. 560). It is now two years since we started the first of the new plants in operation, and since then not one of the boilers using treated water exclusively has gone to the shop for boiler repairs. Previously, every boiler spent about two months in the shop every year.

In addition to improved service on that 130 miles, and a reduction of $129,000 in operating expense, we have released three of the fourteen engines, whose construction cost was more than that of the water-treating plants. And what is true on the 130 miles is true all over the treated-water district. Water-treating plants may repay more than their construction cost in a few weeks by the release of engines and by increasing the speed and service value of cars.

Colorado-Nebraska Water Treaty Signed

LITIGATION over water rights between Colorado and Nebraska has been concluded by a compact recently signed by officials of both states. Thus ends a controversy started in 1916 by Nebraska in the federal courts against Colorado appropriations of water, which would normally come to Nebraska, and state water officials. It affected the rights of all appropriations in Colorado with priority junior to June 19, 1897. Studies made of the legal and physical phases included elaborate surveys of seepage and return supplies available for the service in both states. The *Engineers' Bulletin* of the Colorado Society of Engineers sums up the situation:

A limited area can be served in Nebraska by ditches diverting water in that state, but the fertile lands in Perkins County can be reached by a canal to head in Colorado above Julesburg. The possibilities of service to these lands by the interstate canal (the proposed Perkins County canal) was early brought to the attention of the authorities in Nebraska and the desirability of a treaty between the states for settlement of pending disputes and opening the door to future development has been discussed by counsel for Colorado ditches with the Nebraska officials since 1917.

In 1917 the Colorado legislature enacted a statute forbidding the diversion of water in Colorado for use upon lands in another state without previous consent of Colorado. Nebraska has been unable to commence construction of its canal until the conclusion of a treaty with Colorado.

In early days the South Platte River was dry during the summer months at points below Fort Morgan. The irrigation of lands upon the tributaries and along the upper river produced an ever increasing return flow which has brought about the development of the country from Greeley to Julesburg. This return flow now supplies the valley lands below Julesburg in Nebraska, as far east as Ogallala. Nebraska makes no use of the water during the winter months, but Colorado stores all of the winter flow to as far east as Balzac and also a part of the winter flow below that point. The use and storage of the return flow coupled with the use and diversion of the flood flow has changed the dry stream of early days to one of constant flow at the state line. More than 100,000 acre-feet of water now pass unused into Nebraska each winter, after supplying all Colorado appropriations. The future development in Colorado will come largely from the storage of flood waters while the development in Nebraska will result altogether from the use and storage of the ever increasing return flow which otherwise would pass the interstate line.

Engineering Literature

A MONTHLY REVIEW OF BOOKS AND A LISTING OF NEW PUBLICATIONS

Testing Materials, Machines and Structures

REVIEWED BY H. F. MOORE

Research Professor of Engineering Materials, University of Illinois, Urbana, Ill.

MECHANICAL TESTING: A Treatise in Two Volumes—By R. G. Batson, M. Inst. C. E., M. I. Mech. E., Associate of King's College, London, Senior Assistant in the Engineering Department of the National Physical Laboratory, Teddington; and J. H. Hyde, A. M. Inst. C. E., M.I.A.E., A. M. I. Mech. E., Senior Assistant in the Engineering Department of the National Physical Laboratory. Vol. I. Testing of Materials of Construction; pp. 413; $9. Vol. II. Testing of Prime Movers, Machines, Structures and Engineering Apparatus; pp. 446; $10. [The Directly-Useful (D. U.) Technical Series.] New York: E. P. Dutton & Co. Cloth; 6x9 in.; many line cuts and halftones.

The scope of this admirable treatise covers the field generally included under the name "Engineering Mechanics." All of Volume I and part of Volume II deal with laboratory problems in strength of materials and strength of parts of machines and structures. Other chapters deal with dynamometers, both absorption and transmission, efficiency tests of gears, the mechanical testing of lubricants and bearings, tests of static and dynamic balance, tests of cutting tools, tests of pressure-measuring apparatus, and mechanical tests with aircraft models.

The chapters on testing materials constitute what is perhaps the best treatise on this subject since the publication of Professor Unwin's well-known "Testing of the Materials of Construction." Enough discussion of theory is included so that the testing engineer who is "rusty" on his theoretical mechanics will need no other reference book at hand in order to follow this book intelligently. The diagrams and photographs of apparatus are numerous and clear. The typography is good. The text descriptions are clear and concise.

The authors have given considerable attention to the significance of test results, to the necessary degree of precision for various tests and to the effect of test conditions upon the accuracy of results. This is a feature especially to be commended, since in engineering laboratory practice sensitiveness and accuracy are often confused, and not infrequently a combination of extremely accurate instruments and instruments of mediocre accuracy is used in such a way that the effectiveness of the accurate instruments is lost.

The book is, of course, written from the viewpoint of British practice and that fact is evident throughout. This does not, however, seriously diminish its usefulness to the American engineer. In the first place, it should be recognized that British laboratory practice is thoroughly good; on the whole present-day British laboratory practice in the testing of materials is fully as careful and precise as is the practice of any other national group of materials testing laboratories. In the pages of this work any American laboratory will find many helpful suggestions for supplementing current test methods.

While this book is written from the British viewpoint it is fairly generous in its references to laboratory practice in other countries, but the authors have not kept in very close touch with recent developments in America. A striking example of this, among several which might be noted, is found in the chapter on tests of concrete slabs where some American tests of several years ago are quoted, but no reference is made to such an important test as that carried out on the floor of the Western Newspaper Union Building by Talbot and Gonnerman. Some time lag in reporting experimental results from the laboratories of another country is unavoidable but that lag seems rather large in this book.

The authors of this work are not content with empirical methods where rational methods can be used. American practice, especially in materials testing, tends to develop toward codified methods of testing and standard specifications. British and continental European practice seems to tend to develop more toward what in America would be called academic methods of testing, and, when specifications and standardized test methods are considered at all, toward specifications and test methods which vary for different consumers. This fact is reflected in the relatively large part of this work given to the theory of testing and the relatively small amount of space given to codified standards of testing.

This book is worthy of careful study by every testing engineer. It is a scholarly discussion of the general principles of testing illustrated by numerous examples rather than a handbook of standard testing practice. It may be said to have been markedly successful in achieving its object which the authors state "is to place before the technical engineer, manufacturer and the student the conditions governing modern testing, together with particulars of standard testing plant and its limitations, and such information as will enable the results obtained to be apprised at their true values."

Steel Erection

HANDBOOK OF STEEL ERECTION—By M. C. Bland, M. Am. Soc. C. E., M. Am. Soc. M. E., Bridge and Structural Engineer, Harrisburg, Pa. New York and London: McGraw-Hill Book Co. Flexible; 4x7 in.; pp. 241; 39 line cuts and halftones. $2.50.

A collection of experience notes, discussions and stress analyses of various erection tools such as locomotive cranes, derricks, and ginpoles, and solution of a number of specimen problems of steel erection, form the substance of this novel book. Very little has been written on erection heretofore, and Mr. Bland's contribution therefore has an importance considerably beyond that which the small size of his book might suggest.

Perhaps the principal value of the book lies in the fact that, throughout, it suggests—by implication rather than expressed statement—that every erection problem and each part of the problem is special, rather than subject to any formula or rule for the solution to be applied. Resourcefulness, familiarity with all the available methods and devices, and a willingness to adopt original procedure based on the requirements of safety and economy are the erection man's prime requisites.

In his analyses of derrick booms, a very large ginpole, and other typical pieces of equipment, the author analyzes the attacking forces and the resistance of the

material clearly and thoroughly, and brings into the calculation numerous items that may easily be overlooked by the designer. This feature of the book is in some respects its strongest element, in the sense of making it a necessity for every responsible erection engineer.

Many Formulas for Index Numbers

THE MAKING OF INDEX NUMBERS: A Study of Their Varieties, Tests, and Reliability—By Irving Fisher, Professor of Political Economy, Yale University. [Publication of the Pollak Foundation for Economic Research.] Boston and New York: Houghton Mifflin Co. Cloth; 6x9 in.; pp. 526; 68 "ratio charts." $7.50.

With the close of the war the computation of index numbers, which was formerly regarded as a harmless diversion of academic statisticians, came to have a bread-and-butter importance to many thousands of people in different occupations. Today it is a matter of great practical moment to know how index numbers are made and to know the right way of making them. Professor Fisher discusses one phase of the question in his latest book, and it need hardly be said that his book merits wide reading.

An index number—as applied to prices, for instance—is a number which represents the general price level in a given field of activity or demand at a given time (or the average during a given month or a given year) as compared with another time taken as the standard; and the index number when written down in sequence for consecutive days or months or years is intended to represent the general price variation in that field during the whole period covered. It is constructed by selecting from the items of price quotation in that field a certain limited numer, and combining them in some plausible way. For example, the index number of construction costs which is quoted month by month in this journal is a composite of certain elements of labor and material, which do not portray any given construction operation but represent it (and any other construction operation) by delegation, so to say.

An index number, then, is always based on something different from that to which it is ultimately applied, or else it would be a direct price quotation. Being general rather than specific, it can not be exact, it is a sort of average both in its origin and in its use. Its nature, therefore, will depend upon the way in which the representative items are selected from the general field, upon the way in which they are combined, and upon the way in which the resulting index number is used. Incidentally, the index number will also depend, it is found in practice, upon the base price—for example, whether construction cost is based upon 1913 or some other year as standard.

Of the numerous points requiring consideration in connection with index numbers, Professor Fisher discusses one, namely, the mathematical procedure to be followed in combining the quotation items selected as components of the index number. Only a few pages are devoted to the selection of items which should go into the index number, and to such questions as the essential need for permanence or stability, freedom from pronounced influence of abnormal conditions in a restricted part of the field, simplicity, availability of data, and the like. Thus the book is essentially mathematical—though the mathematics is simple. Several hundred possible formulas for combining quotation items to form an index number are mentioned, classified and discussed, with the final result that one particular formula is preferred as the ideal. This discussion is very necessary, and as it represents in large part the opening up of a new field, the author's work deserves high commendation.

There is unfortunately no test for an index number. No comparison is available by which its value or its results can be checked definitely. For example, an index number of lumber prices cannot be tested by the quotations for one particular kind and size of lumber, or even by the average prices per thousand feet paid on a few large lumber-using jobs. Its only test is satisfactorily fitting any and all comparison of lumber prices between one year and another, though not fitting any one comparison precisely. Thus there would seem to be no way by which formulas for index number composition can be checked or the superiority of one over another can be determined; the only possible check is in the nature of broad general experience. Suppose a cost-of-living index number be constructed: Its test is not that one particular family spent more in 1916 than in 1915, let us say, nor that 100 families, or all families in the country, spent more. The test is general experience, according to which people quite generally know that it cost more, or less, in 1916 than in the preceding year to maintain existence.

In this difficulty Professor Fisher advances two tests of an index-number formula (*not* a test of an index number itself, it should be noted), and does away with a third that was current heretofore. His two tests, which he apparently considers of absolute validity, are time reversal and factor reversal. According to the former, an index number computed for a particular year (the given year) from the base year must be the reciprocal of the index number found by basing on the given year and calculating the value for the original base year. Factor-reversal means that the formula should be homogeneous in price and quantity, so that when prices and quantities are interchanged a number will result which when multiplied by the original index number will give the actual total-value ratio. But in spite of his faith in these tests, Professor Fisher finds that many formulas can be devised that will satisfy both tests and yet give different results.

Of a great many interesting quotations that might be given here, two may be cited as suggestions of the difficulties involved in the subject-matter of the book:

"When the number of samples used is small, an unwise choice can spoil the results; even the best available assortment and number of commodities cannot yield the same degree of accuracy as the merely mathematical accuracy of the formula (p. 331).

"We cannot justify using the same weights for comparing the price level of 1913, not only with 1914 and 1915, but with 1860, 1776, 1492, and the times of Diocletian, Rameses II, and the Stone Age" (p. 275).

Roads, Canals, Railways and Transport

HIGHWAYS AND HIGHWAY TRANSPORTATION—By George R. Chatburn, Professor of Applied Mechanics and Machine Design, Lecturer on Highway Engineering, University of Nebraska. New York: Thomas Y. Crowell Co. Cloth; 6x9 in.; pp. 472; line cuts, maps and halftones. $3 net; postage extra.

As a narrative of canal, railway and highway development and as a plea for the co-ordination of all these ways of transportation this volume is commendable. It is not a book that will greatly serve the highway or the automotive engineer in his technical tasks. This is not its object. It will serve engineers in a large way,

however, by giving them a background of historic beginnings and early problems in the growth of ways of transportation. Touching as it does the romance of early trail making, the road work of the ancients, highway esthetics and aids and attractions to travel the book is particularly one for the general reader. It will also help him understand the financing and planning of highway systems. There are chapters on ancient roads, early trails, canals, railways and finally the modern wagon road. Then come five chapters on the planning and economies of highways. There is one chapter on automotive transportation, one on accidents, one on esthetics and one on aids and attractions to traffic and travel. The volume has a good index.

Flexural Action in Beams

REVIEWED BY GEORGE PAASWELL
Consulting Engineer, New York City

ELASTICITY AND STRENGTH OF MATERIALS USED IN ENGINEERING CONSTRUCTION: Section II, Theory of Flexure—By C. A. P. Turner, M. Am. Soc. C. E., Consulting Engineer. Minneapolis, Minn.: The Author. Cloth; 6x9 in.; pp. 108, illustrated. $5.

This little book, forming Part II in a series on "Elasticity," purports to give an exposition of exact flexural action in beams by a practical and elementary treatment of matter now found only in treatises upon elasticity. The author lays much stress upon the failure of engineers to avail themselves of material in such treatises, overlooking the fact that the salient features of such exact analysis are incorporated in all modern design. It was St. Venant who indicated the error of the ordinary theory of flexure insofar as a plane section was assumed to remain plane after bending, pointing out that such sections become warped, due to shear action; but the exact problem of flexure was solved only for the cantilever carrying a load at its terminal and for the simple beam with a uniform load. The important result was the fact that the warping of the plane cross-section by shear becomes of serious nature near the support or places of maximum shear only. This is duly appreciated by all designers but is apparently overlooked by Mr. Turner. The reader is therefore led to anticipate novel data on beam design, which, of course, are not forthcoming.

Beyond this, the book is characterized by the fact that in undertaking to carry out the plan of an "elementary" discussion the author has been compelled to sacrifice both clearness and rigor in the demonstrations. In any attempt to prove a controversial question it is fatal to fill gaps in the reasoning by flat statements, supported only by the authority of the demonstrator, and while it may be excusable in a handbook to present a bare formula, a textbook must go farther, even when it deals with flexural action, where connected description cannot be given without the aid of the calculus. It is not surprising, therefore, that the labored and verbose discussion in the book is far from convincing, and in a number of instances becomes unsound and even erroneous reasoning.

Thus the statement that shearing strains rotate the normal section of the beam about the gravity axis by an amount proportional to the slope of the deflection curve cannot be reconciled with the observation that shearing strains merely warp a section into an anti-elastic surface.

Further serious difficulty for the reader arises from the author's confusion of shearing stress distributed over an entire section with shearing intensity at a point, which leads him to results that violate the fundamental laws of statics. It is fatal to any demonstration to leave the reader with an impression that basic laws of statics are void for one particular stress type.

The author discusses arch action and flexural action as if the two involve separate types of stress. This not only leaves a wrong impression in the reader's mind but makes it exceedingly difficult to derive a proper expression for such arch action. Arch and beam differ only in their terminal conditions, and it is evident that when the equation of the elastic curve is determined on the assumption that there is no displacement at the supports it will define arch action precisely. In other words, "arch action" is merely a special name for a certain type of flexural action easily calculated by the ordinary laws of flexure.

The book contains an excellent and clear discussion on continuous girders, giving a graphical picture of the moments and reactions in girders of any number of spans carrying a uniform load.

Present-Day Penstock Design

REPORT OF HYDRAULIC POWER COMMITTEE, N.E.L.A.—Prepared by the Hydraulic Power Committee of the Pacific Coast Electrical Association. A Condensed Report of Recent Advances and Improvements in Penstock Design, More Particularly in High-Head Installations Such As Are Typical of Western Development. New York: National Electric Light Association. Paper, 8x11 in.; pp. 80; illustrated. 55c.

The National Electric Light Association at its recent convention in New York City adopted a report on penstock design that embodies much useful information evidently made available in this convenient form only after much work by a representative group of hydraulic engineers. Although the action of the convention makes this an official report of the hydraulic power committee of the association, the work of compilation has been done in the West under the direction of the hydraulic power committee of the Pacific Coast Electrical Association, a branch of the parent body. O. G. Thurlow was chairman of the national hydraulic committee. The report deals almost wholly with high-head developments and other problems peculiar to the West.

The committee was made up of about thirty representatives of Western power companies, municipalities and manufacturers. Under the direction of H. L. Doolittle, assistant chief engineer, Southern California Edison Co., this committee held several sessions at which there was a general discussion of the subjects covered. The discussions were directed toward bringing out those features of each company's experience that would constitute information of value to other companies in considering similar problems. The report has in it nothing of an elementary nature nor does it go deeply into mathematics, the purpose being rather to present a symposium on the latest and best methods of meeting the more important problems in penstock design and construction. For example, reasons for the present practice, as indicated by experience with recent installations, are cited in the planning of expansion joints, air vents, and anchorages, and in determining friction losses, pipe thicknesses, etc.

While no favoritism is shown, trade names and the names of manufacturers are mentioned freely. Statements by manufacturers are an interesting feature and those included within the body of the report proper are in keeping with the spirit of the report as a whole and are evidently earnest endeavors to contribute information without any attempt at advertising. The

inclusion of specifications adopted by the A.S.T.M. indicates a desire to make the report of value as a reference work on penstock design.

There is no index nor are the several subjects arranged and introduced separately. The data on draft tube tests should be studied in connection with later reports on the same subject made on tests for the U. S. War Department at the Muscle Shoals plant. As a whole, however, the report is in a much higher class than the ordinary committee production; no space is wasted on non-essentials and it contains much valuable information not heretofore published. In the West where there has been a limited advance circulation, the report has been very favorably received and pronounced "the most valuable collection of data on penstock design ever compiled in one publication."

A Comprehensive Structural Treatise

REVIEWED BY CHARLES A. MEAD

Chief Engineer, Division of Bridges and Grade Crossings, State Public Utility Commission, Newark, N. J.

STRUCTURAL MEMBERS AND CONNECTIONS—Compiled by a Staff of Specialists—Editors-in-Chief, George A. Hool, S.B., Consulting Engineer, Professor of Structural Engineering, University of Wisconsin, and W. S. Kinne, B.S., Professor of Structural Engineering, University of Wisconsin. New York and London: McGraw-Hill Co. Cloth; 6x9 in.; pp. 611; illustrated. $6.

Many excellent works on structural analytics have been produced since volumes of joint authorship began to make their appearance thirty years ago but none have given the subject matter such comprehensive and logical treatment as this one. It is the second of a series of six volumes, each dealing with a principal subdivision of structural engineering, and is sponsored by Messrs. Hool and Kinne, who with nine associate editors, specialists of wide reputation, have given of their best to produce it.

Three principal structural materials are dealt with: ferrous metals, wood and concrete. Following complete definition, general theory is developed, which in turn is followed by the design of members and their connections. The effect of unsymmetrical and essential loading is treated at great length. Where approximate solutions are permissible within practical limits they are also given. Helpful suggestions of practical limitations are sprinkled throughout the work and numerous illustrative problems are worked out numerically so that the student is not left in the dark as to the practical application of the problem. The diagrams are well drawn and unusually clear.

A work of this character must represent modern practice in order to be valuable, and therefore must contain material copied from mill books and shop practice sheets. It is refreshing to note that all such borrowed material is up to date and truly represents modern practice. As each volume of this series purports to be a complete treatise in itself, it is excusable if some of the material occurring in other works by the same authors has been reproduced here. The volume is particularly free from padding in any sense, however.

Often different methods of solving a problem are given, illuminating it from different angles. The book is written from the true teacher's standpoint which has in mind the student's attitude. It will therefore find a useful place in the student's library, whether he be undergraduate or practitioner. In short it is a comprehensive presentation of just what its title indicates, and is worthy of high rank among books of its class.

The Electric Power Industry

ATLAS OF U. S. A. POWER INDUSTRY, Outlining Suggested Regional Power Districts and Proposed Constant-Potential Transmission Systems for the United States of North America —By Frank G. Baum, Consulting Hydro-Electric Engineer, Fellow A.I.E.E., M. Am. Soc. M. E., M. Am. Soc. C. E., San Francisco, Calif. New York and London: McGraw-Hill Book Co. Cloth; 17x11 in.; pp. 21 of text and pp. 34 of map and diagrams. $10.

An immense amount of labor is represented in this interesting and valuable survey of the electric power industry and brief for regional power districts. After giving a brief history of the electric power industry in America and stating the problems of the industry, Part I of the book presents the advantages to be gained by grouping small plants into large systems and then suggests a group of regional electric power districts and a constant-potential electric transmission system. This is followed by a summary of the mechanical and electrical power used by industries and utilities in this country, by a description of water-power development, and by much valuable information on the generator capacity and output of central stations, the use of mechanical and electrical power in manufacturers' plants and in mines and quarries, and on the steam and electric operating situation of the railways of the United States. This part of the book closes with a discussion of the effect of diversity on load factor and the economic proportion of hydro-electric and steam power.

Part II is devoted to a discussion of the present power transmission systems, the need of large-capacity transmission lines, and a description of the constant-potential system by the author. The 24 pp. of maps and diagrams in Parts I and II give a complete graphical representation of the material in the text and supplementary information as well.

Part III, General Data, United States and the World, consists of 10 pp. of maps and diagrams which give such information as the developed and undeveloped water powers of the world, coal fields and gas and oil fields of the United States, precipitation and land altitude for both the United States and the world, and the forest resources of the United States.

PUBLICATIONS RECEIVED

Notes on Pamphlets and Reports

THOSE WHO NEED SOME LIGHT READING, combining entertainment with engineering instruction, will find Brearley's "A Symbol of Safety" well worth their time. The author recounts the evolution and the present work of the world-famous Underwriters' Laboratories, and succeeds in presenting a really effective picture of its many-sided activities. Going beyond the electrical safety and quality testing—which, in fact, was the foundation of the laboratories and still constitutes one of the most important sections of its work—and the investigation of building materials and building units, he takes up the little known but decidedly interesting work being done on burglar protection, on automobile safety, airplanes, and the like. The style is easy, and the matter appears quite free from the distortion and exaggerated emphasis common in semi-popular writing. There are many excellent illustrations. (Garden City, N. Y.: Doubleday, Page & Co.; $2.50.)

FOR MORE SUBSTANTIAL TECHNICAL READING the engineer will find it profitable to take up the second report on Fatigue of Metals just issued as Bulletin 136 of the Illinois Engineering Experiment Station (by H. M. Moore and T. M. Jasper; Urbana, Ill.; pp. 100; 50c.). Most of the results reported amplify and substantiate the results previously presented, which tend to establish a definite endurance limit, namely,

a stress at or below which an indefinitely large number of reversals can be carried by the material. Among the new tests are some which indicate that a few moderate overstressings will not reduce the endurance strength of the material to any great degree. However, the important new element in the work now reported is a large series of tests in which the upper and lower stress limits were not equal and opposite, but instead the variable stress ranged from a moderate compression to a high tension, or else varied in tension only. The results do not support the range-of-stress theory advanced by Goodman in England some years ago, according to which the effect of the variable item of stress is double that of the constant stress item. The endurance limit in these tests seems to bear a linear relation to the ratio of minimum to maximum stress.

A DESCRIPTIVE SURVEY of the Detroit water-works has been issued by the Water Commissioners of that city (G. H. Fenkell, superintendent and manager). This unique pamphlet of only 40 pp. contains twenty-three short papers each describing a branch of the organization or its work and each written by the official in charge. Thus Mr. Fenkell treats of the general organization; H. W. Gould, superintendent, describes the pumping stations; F. H. Stephenson, assistant superintendent, the distribution system. Others take up finances, records, construction, meters, billing, accounting, auditing, pitometer operations, personnel, etc. Over 3,000 copies have been distributed among the public and parochial school teachers of Detroit and further copies are available, Mr. Fenkell states, for any one interested anywhere.—THE DETROIT FILTRATION PLANT is described in a separate pamphlet, by Theodore A. Leisen, consulting engineer, Detroit water-works.

MUNICIPAL AND MANY OTHER ENGINEERS should welcome Use of Geodetic Control for City Surveys, by Hugh C. Mitchell, mathematician, U. S. Coast & Geodetic Survey, an illustrated pamphlet containing a map showing areas of United States now covered by triangulation and also net of precise leveling (20c. from Superintendent of Documents, Washington, D. C.).

THE MECHANICS OF THE ACTIVATED SLUDGE PROCESS, a paper by J. A. Coombs, an engineer on the staff of Activated Sludge, Ltd. (14 Howick Place, Victoria St., Westminster, England) has been reprinted from its April *Journal* by the Institution of Sanitary Engineers, 120 Victoria St., Westminster, England (pp. 48, including 7 pp. of discussion; illustrated; 1 s.). The paper will be found interesting and valuable by all who are following sewage treatment in detail and particularly by those who wish to get an idea of British practice and opinion from the viewpoint of the British promoters of the activated-sludge progress.

THE SEWERAGE AND SEWAGE DISPOSAL of New York City is reviewed in a supplement to the May *Sewage Disposal Bulletin* of the Board of Estimate and Apportionment, New York City, issued in honor of the "twenty-fifth anniversary of the Greater City of New York." Arthur S. Tuttle is chief engineer and Kenneth Allen is sanitary engineer of the board.

THE MINISTRY OF PUBLIC WORKS of Czechoslovakia (Prague) has begun issuing a press information sheet in English entitled Zpráry veř. služby technické (News of Public Technical Service).

AUSTRALIAN GOVERNMENTAL ACTIVITIES AND STATISTICS for the whole country and for the separate states are detailed in the 1922 Official Year Book of the Commonwealth of Australia. The general and local government schemes are outlined and personnel is given, as well as statistics of various public works and the present status of local water supplies, etc. (Melbourne: Bureau of Census and Statistics.)

ACTIVATED-SLUDGE STUDIES, third series, 1920-22, by the Illinois State Water Survey, Dr. A. M. Buswell, chief, are described in the results summarized in a bulletin just published at Urbana. There are sections on the biochemistry of the process, microbiology and the theory of activated sludge, and sludge-drying experiments.

VALUABLE INFORMATION AND OPINION on many phases of water treatment is given in the report of the Ohio Conference on Water Purification held at Columbus last November, edited by F. H. Waring, principal assistant engineer, Ohio Department of Health, Columbus. Besides committee reports and general discussion the report contains eighteen papers by various experts and operators.

PERMISSIBLE EXPLOSIVES AND MINING EQUIPMENT approved by the Bureau of Mines prior to Jan. 1, 1923, are listed and discussed in Technical Paper 333 of the Bureau.

AN APPROPRIATION OF $200,000 has enabled the California State Department of Public Works, Division of Engineering and Irrigation, assisted by a consulting board of engineers and other engineering advisors, to publish an extensive report on the Water Resources of California. Besides the main report to the Legislature as of Jan. 1, 1923, there are these four appendixes: Flow in California Streams, with many tables and diagrams; Irrigation Requirements of California Lands; Utilization of the Water Resources of California; Relation of Settlement to Irrigation Development, prepared by Dr. Elwood Mead, University of California.

New Books and Revised Editions

DIE BERECHNUNG DES SYMMETRISCHEN STOCKWERK-RAHMENS mit geneigten und lotrechten Ständern mit Hilfe von Differenzengleichungen—Von Dr. techn. Josef Fritsche Ingenieur, Assistent an der technischen Hochschule in Prag Berlin: Julius Springer. Paper; 6x9 in.; pp. 90; line cuts.

THE BUSINESS LETTER: Its Principles and Problems—By Carl A. Naether, Associate in Journalism, University of Michigan. New York and London: D. Appleton & Co. Cloth; 6x9 in.; pp. 516. $4.

A detailed analytical and descriptive work on the subject.

THE ELECTRICAL HANDLING OF MATERIALS: A Manual in Four Volumes, on the Design, Construction and Application of Cranes, Conveyors, Hoists and Elevators—By H. H. Broughton, M. I. Mech. E., M. Inst. E. E. Vol. IV. MACHINERY AND METHODS. London: Ernest Benn, Limited. Cloth; 9x12 in.; pp. 334; 279 line cuts and half-tones, some on folding plates. 50s. net.

The earlier volumes were: I., Electrical Equipment; II., Structural Steelwork and Mechanical Equipment; III., Cranes and Crane Mechanisms. The present and concluding volume takes up elevators and conveyors, belt conveyors, automatic feeders and skip hoists; Lessons from America in the Bulk-Handling of Materials; handling and storing grain, coal, ore, etc. There is a chapter on Panama Canal Coaling Stations.

ELEMENTS OF GRAPHIC STATICS—By Clarence W. Hudson, C.E., Am. Soc. C. E., Professor of Civil Engineering Polytechnic Institute of Brooklyn, N. Y., Consulting Engineer, and Edward J. Squire, C.E., M.S., Assoc. M. Am. Soc. C. E., Assistant Professor (as above). New York and London: McGraw-Hill Book Co. Cloth; 5x7 in.; pp. 91; illustrated. $1.25.

Confined to what authors think are the essential to working requirements for civil and other engineering students, "especially as to the calculations of reactions, stresses, shears and moments. * * * may be found useful to the practicing engineer in enabling him to review in brief and compact form the application of the subject to the solution of structural problems."

THE EMPIRE MUNICIPAL DIRECTORY AND YEAR BOOK for 1923-24: Complete and Authoritative Lists of all the Corporations, County, Urban and Rural District Councils, with their Populations, Municipal Undertakings, Names of their Administrative Officials, etc., in Great Britain, the Colonies and Overseas Dominions, and a Compendium of Information relative to Municipal Engineering and Public Health Work and Practice. London: Sanitary Publishing Co., Ltd. Cloth; 7x9 in.; pp. 349. 11s. postpaid.

New features of this useful directory include sections on labor saving plant and appliances and on institutions that grant degrees or diplomas in public health.

FOUNDATIONS, ABUTMENTS AND FOOTINGS—Compiled by a Staff of Specialists—Editors-in-Chief, George A. Hool, S.B., Consulting Engineer, Professor of Structural Engineering, University of Wisconsin, and W. S. Kinne, Professor of Structural Engineering, University of Wisconsin, Assisted by Horace S. Baker, S.B., Chief Engineer, Frank D. Chase, Inc., Chicago. New York and London: McGraw-Hill Co., Inc. Cloth; 6x9 in.; pp. 414; illustrated. $4.

HANDBUCH DES WASSERBAUES für Studium un die Praxis—Von Hubert Engels. Third Edition. Cloth; pp. 1,649, in two volumes; 1,736 line cuts. Leipzig: Wilhelm Engelmann.

In the present revision the size of this book has been increased by 35 pp. The first edition was reviewed in *Engineering News*, June 21, 1915, p. 116, and the second edition in *Engineering News-Record*, June 16, 1921, p. 1045, in each case by Allen Hazen.

MOTOR TRANSPORTATION OF MERCHANDISE AND PASSENGERS—By Percival White, Research Engineer; Formerly Manufacturer of Projecta Cars, London, England; Director of Development, Aluminum Manufacturers, Inc., Cleveland, Ohio; and Ordnance Expert, War Department; M. Am. Soc. M. E., Soc. Automotive E., etc. Cloth; 6x9 in.; pp. 486; illustrated. $4.

Letters to the Editor

This department aims to be a forum for the discussion of the views of engineers and contractors. The range of interest should be as wide as possible. Contributors are, therefore, asked to make their letters short.

Rudolph Hering

Sir—With the passing of Rudolph Hering from the active stage of engineering progress the profession has lost one of the most distinguished and picturesque characters among the older men.

He was a sanitary engineer who was particularly noted for his ability and wide learning in the specialty of sewage works.

The writer was associated with Dr. Hering on several commissions and had an excellent opportunity for becoming acquainted with the wide range of his learning in this and other branches of engineering science.

He was ever ready to discuss intricate questions connected with his specialty and to counsel younger men whenever the opportunity occurred.

Dr. Hering was deeply interested in the welfare of engineering societies and added frequently to their investigations and discussions of the Am. Soc. of Civil Engineers.

DESMOND FITZGERALD.

Brookline, Mass., June 13, 1923.

Coating Does Not Restore Corroded Sprinklers

Sir—The article by Mr. C. C. Brown on the care of sprinkler heads on page 869 of the May 17 issue of *Engineering News-Record*, while well meant, is liable to lead to false conclusions and dangerous practices. Sprinklers from industrial plants of all kinds and therefore subject to a variety of external and internal deteriorating influences are being constantly tested under standard conditions in laboratories equipped especially for this purpose. The data thus obtained are studied, classified and compared with previous experience. Then suitable recommendations are made.

The experience of the Factory Mutual Laboratories covering more than thirty years of sprinkler testing would not confirm in all respects Mr. Brown's conclusions or his recommendations. We have not found that sprinklers subject to salt air should be either protected or inspected every few months as Mr. Brown has decided. There are millions of sprinklers along the Atlantic sea-board which have been exposed to salt *air* for many years without being more than tarnished. If supplied by pumps taking suction from salt *water* there may be some trouble from leakage after long continued exposure. We wonder if this may not be one of Mr. Brown's difficulties.

Although we have seen hundreds of sprinklers which have suffered mechanical injury, we know of no cases where the solder has "come loose," although occasionally sprinklers subjected to excessive temperatures may have the soldered joint weakened.

The statement in Mr. Brown's article which we consider dangerous is the advice to clean corroded sprinklers and then coat them with a protective material. Many attempts have shown that it is not practicable to clean a corroded sprinkler with the assurance that it will be reliable for fire protection. Corrosion frequently attacks the solder and oftentimes progresses part way into the soldered joint. This trouble cannot be remedied by cleaning; neither can the corrosion be removed from the fine joints in the releasing mechanism. The protective solution which Mr. Brown recommends, consisting of linseed oil, rosin and paraffin, will harden with age as the oil oxidizes and may prevent the operation of the sprinkler just as effectively as corrosion. Dipping the sprinklers, which are rated to fuse at about 160 deg., in a solution heated to 190 deg. is also considered unwise advice as it is likely to weaken the soldered joint.

We are calling these matters to your attention because readers of your paper may be misled by Mr. Brown's article and attempt to test, clean and protect their automatic sprinklers with harmful results.

Yours truly,

FACTORY MUTUAL LABORATORIES,
C. W. MOWRY,
Director.

Boston, Mass., June 13.

Sir—Regarding the article by C. C. Brown in the May 17 issue of the *Engineering News-Record* we are sorry that this article has had the prominence its publication in the *Engineering News-Record* gives it. We feel sure that you will find that experience of laboratories tests shows conclusively that it is not possible to restore the sprinkler head to operating condition, once it has been affected by corrosion, by any process of cleaning. Also, that corroproof coatings should be applied to new clean heads which have never been installed in a sprinkler system or subjected to corroding influences.

The suggested recipe contained in Mr. Brown's article for corroproofing is open to criticism because it contains boiled linseed oil and rosin, both of which are extensively used in varnishes because of their oxidizing qualities. Experience shows that sprinkler heads painted or varnished are not only tardy in action, but frequently fail to operate because the parts are liable to stick due to the paint. Another objectionable feature of this mixture is the temperature at which it is applied, viz., 190 deg. or thirty degrees above the temperature of the average sprinkler head.

We feel sure that all fire protection engineers will agree that the suggested treatment would be very harmful to the sprinkler heads.

W. J. CHATTIN,
Manager Engineering Dept., New York Reciprocal Underwriters and Affiliated Underwriters.

New York, June 18.

A New Employment Service by A. A. E.

Sir—Development of employment service in the American Association of Engineers has been proceeding lately somewhat along the lines proposed by Morris L. Cooke in his article in *Engineering News-Record*, May 10, 1923, p. 830.

At its meeting in Norfolk the board of directors of the Association authorized taking out a charter to conduct an employment service for the engineering profession on a non-profit basis. The charge will be 25 per cent of the first month's salary or about 2 per cent of the annual salary. The name of the new corporation is "Association Employment, Inc." It is designed to serve engineers who are not members of the American Association of Engineers.

This new service is distinct from that to members which is rendered by the national office for 10 per cent of the first month's salary and free by all Class A chapters except one. The fees for member service are in the nature of a contribution, and are not collectible at law.

The board of directors regarded the departure into the field of employment service under the wing of the Association to all engineers as an experiment and an expedient; an experiment because the field is uncharted and an expedient because our clients are calling for several times more engineers than can be supplied from our membership. The first test of good employment service is such a degree of satisfaction to the employer that he will find it superior to any other method of finding just the man he wants.

Any paid employment service for all engineers obviously should be managed along lines proposed by Mr. Cooke or along similar lines. Speaking for the American Association of Engineers, I can say that it is ever ready to co-operate with other societies for the solution of common problems. This principle has been frequently stated by the Association in its annual conventions and by the board of directors, and was reaffirmed by resolution of the Norfolk convention. With specific reference to employment, the Association not

only stands ready to co-operate in developing the most effective national employment service for professional engineers, but stands ready to take the responsibility of experimentation and leadership in this enlarged field.

WEBSTER L. BENHAM,
President, American Association of Engineers.

Kansas City, Mo.,
May 19, 1923.

Lettering Jigs Again

Sir—Referring to the letter by L. B. Tuckerman, in your issue of May 10, 1923, p. 843, as the inventor of the "Wrico lettering system," I have made a very thorough investigation of all available records of devices which have at various times been put forward, both in this country and abroad, for the purpose of alleviating the irksome task of lettering. With the knowledge thus gained of other devices, I feel obliged to say that the word "similar" as used by Mr. Tuckerman, in making a comparison between the "Wrico" system and others, must be taken in a very limited sense. It is a fact that most of them act as guides for the marking instrument, but there the similarity ends, for in no other device do I think is found the possibility of speed coupled with the perfect lettering which can be executed by the "Wrico" system.

EDWIN C. WOOD,
Manager, The Wood-Regan Instrument Co., Inc.

New York City,
May 31, 1923.

Terminals for Water-Borne Traffic at Chicago

Sir—I have read with considerable interest your editorials of April 5 and May 24, pp. 609 and 906, and R. I. Randolph's letter to the Editor in the issue of April 19, p. 721, all on the subject of closing the Chicago River. Without intending to be critical, but merely hoping to stimulate and continue the discussion thus ably begun, which must necessarily preface serious consideration and study of the problem, it is my belief that none of the articles referred to has gone to the very bottom of the matter. Possibly your editorial of May 24 did much to eliminate extraneous considerations from Mr. Randolph's elaboration of the problem, but it did little towards building up in the mind of the reader a true picture of the situation. Destructive criticism has never helped to solve as important a question as this one.

What is the question with which we are dealing? Is it about the engineering difficulties involved in the conversion of the Chicago River to a closed sewer? Is it about the legal difficulties to be encountered in denying to owners and operators of masted vessels the privilege of using the river as a highway, or in denying to riparian interests their access by water to the Great Lakes? Is it that it is cheaper to build and maintain fixed bridges than movable ones?

It is true that the determination of some of these problems may affect the real issue, but in general they may be solved to better advantage after the basic considerations have been properly disposed of.

Stripped of all side issues and irrelevancies the question might be put this way: What terminal facilities should the city of Chicago provide for its present and future water-borne commerce?

We have on the one hand, if you please, a definite amount of existing commerce which should be properly cared for and which will necessitate certain expenditures on the part of the city. We also have an indefinite amount of future commerce which requires no special expenditure at the present time other than that necessary to plan ahead for it and see that certain vital necessities are not dedicated to purposes which would forever preclude their being used as the part of any future plan of development.

On the other hand we have the determination of the value to the city of the advantages of a lake and river commerce which in all probability would thrive if provided for adequately. And we also have to evaluate, if that is possible in this case, the obligation of the city to the nation. For Chicago is not a city unto herself. She is a great city because she stands at the cross-roads of great highways of national commerce, and by virtue of such a position she is dependent upon the rest of the nation for her very existence.

This obligation to the nation, added to the advantages enjoyed in a commercial and industrial way from a strategic location at the head of Lake Michigan, must be weighed against any expense to which Chicago might be put to provide the requisite terminal facilities. Federal expenditures for the improvement of Chicago Harbor are not intended to be for the sole benefit of Chicago; they would not be justified unless the people of this nation, represented by a majority in Congress, saw fit to appropriate for the works as national improvements.

There is no question but that a wide, open, straightened river, coupled with ample facilities on the lake front, would represent an ideal solution as regards the shipping interests, both lake and river. A roofed-over river with certain terminal facilities on the lake front and a connection from the lake to the Illinois Waterway provided by way of the Sag Channel would represent the other extreme. Somewhere between the two lies a solution which will answer the proper demands of navigation and fulfill the obligation of the city of Chicago to the nation without demanding any great sacrifice.

Allow me to correct one misapprehension under which you are laboring. You say, "We are nearer facing the question of who in the last analysis is entitled to exercise control over the navigation of such a stream—the Federal Government or the community which the stream serves." There are numerous court decisions, and at least one of the Supreme Court of the United States, which indicate the national character of the Chicago River and hold it to be one of the navigable waters of the United States; and with respect to such waters Section 10 of the River and Harbor Act of 1899 states in part:

"That the creation of any obstruction not affirmatively authorized by Congress, to the navigable capacity of any of the waters of the United States is hereby prohibited; . . ."

As regards the constitutionality of that Act and its application to the Chicago River there can be little doubt.

Solve the water terminal problem at Chicago based upon sound premises as to classes, volume and routes of water-borne commerce, and all these other questions will be disposed of. But arguing them before the main issue is determined is a waste of effort and only delays the solution of the real problem.

RUFUS W. PUTNAM,
Major, Corps of Engineers, U. S. Army,
District Engineer, Chicago District.

Smaller Cement Sacks

Sir—Your editorial on smaller cement sacks in *Engineering News-Record*, March 29, 1923, p. 565, recalls the writer's brief experience, now nearly twenty years ago, as checker receiving and disbursing cement at the storage sheds for an important piece of work in Greater New York. Anyone in a similar position who is responsible for the receiving, sorting, cleaning and shipping of empty cement sacks should welcome the paper sack which he would never see again when once checked out. On a large piece of work the "Wop" at the mixer never shakes out all the cement and it is often worth while to employ a man for the disagreeable job of turning and reshaking the empty sacks.

In striking contrast to this the writer also distinctly recalls a still earlier time when natural cement was cheaper than portland and came in paper bags. The bags were broken by dropping on the mixing board or were spit open with a shovel and the paper pulled away clean. *All* the cement went into the concrete. The use of fifty pound packages should compensate for the loss which occurred by breakage of the larger packages during transit and handling. It therefore seems that a number of very obvious advantages would result from the suggested change.

Tientsin, China, May 9, 1923. R. D. GOODRICH,
Engineer in Charge of Works,
Commission for the Improvement of the River System of Chihli.

News of the Week

CURRENT EVENTS IN THE CIVIL ENGINEERING AND CONTRACTING FIELDS

News Brevities

The Pennsylvania R.R. Has Completed its track elevation through the City of Camden, N. J.

On June 25 the City of St. Louis, Mo., will sell the first block of $2,500,000 of 4½ per cent twenty-year bonds authorized under the recent bond issue, passed by that city, for $87,420,000.

Operating Expenses of the Government-Owned Alaska R.R. for the year 1922 totaled $1,772,376 while the operating income was only $718,920. This leaves a deficit of $1,053,456 for the year and a total deficit, since construction began in 1915, of $7,055,224.

License Has Been Granted by the Federal Power Commission to the Alabama Interstate Power Co. for the development of the Cherokee Bluffs site on the Tallapoosa River. Later the licensee will ask to assign the license to the Alabama Power Co. for construction and operation.

The Pennsylvania R. R. System announces a $2,000,000 improvement program in the Northwest, the improvement to include deepening the slip at Sandusky coal dock, extending its tracks from Webbs to Walbridge, increasing its trackage at Crestline, and installing a block signal system from Grand Rapids to Mackinaw City.

The Cleveland Union Terminals Co. has been authorized by the Interstate Commerce Commission to issue $15,000,000 bonds for the purpose of acquiring additional land and for construction work. The bonds are to be guaranteed as to principal and interest by the N. Y. C., the C. C. C. & St. L., and the N. Y. C. & St. L. railroad companies.

By a Public Reprimand of the Pennsylvania R.R. Co., the Railroad Labor Board has arraigned that company for its contempt of the findings of the board in the matter of determining employee representation on the Pennsylvania System. The Transportation Act provides no way whereby the findings of the Labor Board can be enforced, consequently this formal action closes the case, at least insofar as the present action is concerned.

The Canadian Government is Asking Parliament for appropriations amounting in all upwards of $25,000,000 for the construction of extensions to the Canadian National Rys., covering 29 projects which have been recommended by President Thornton. Of this total nearly $18,000,000 will be expended in the Prairie Provinces, $3,000,000 in British Columbia, $5,000,000 in the Maritime Provinces, $2,000,000 in Ontario and less than $500,000 in Quebec.

Yale and Union to Teach Building Construction

Through gifts from the trustees of the Louis J. and Mary E. Horowitz Foundation, courses in building construction have been established at Yale University and Union College. The organization in charge of the course will be known as the Thompson-Starrett Foundation.

The Thompson-Starrett Co. offers to provide two annual prizes of $2,500 each to be awarded each year to graduates of the course who shall commend themselves by the quality of their work and by their promise as practical building constructors, and who desire to connect themselves with the Thompson-Starrett Co. for practical training in their chosen calling.

The course in building construction is to be offered as a development of the civil engineering course, rather than an appendage to a course in architecture. This move is made upon the theory that building construction is looked upon more as a profession in itself than subordinate to architecture.

In proposing the establishment of such a course and undertaking to support it, the purpose in view was to supply a number of technically-trained and educated men to perfect the capacity and work of the constructor with the hope that building construction would become a profession as dignified as architecture, and on a parity with it. In establishing the courses the donors do not propose to diminish the importance of the architect or exalt that of the constructor, but to recognize the trend of events and the conditions existing in the building industry and to make every effort to meet them to the satisfaction of the public.

Concrete Formwork for Theater Damaged by Trainshed Fire

Slight damage was caused recently at the Fox Theater in Philadelphia by burning of the formwork for the concrete floor at the fourteenth tier of the steel structure. The fire was started by the disastrous blaze that destroyed the Broad Street Station trainshed of the Pennsylvania R.R. The Fox Theater is being erected at the southwest corner of 17th and Market Street, directly opposite the portion of the trainshed in which the flames reached the greatest height. Formwork, consisting of boards 1 in. thick, was practically complete for the fourteenth floor, and timber was piled on the fifteenth floor. The forms in three bays on the Market Street side were burned. City firemen extinguished the flames without difficulty and the timber on the fifteenth floor was not burned. The heat produced by the burning forms at the fourteenth floor was so great, however, that the 18-in. I-beams were badly twisted. The columns were not damaged, and no damage was done to completed concrete work below, according to Wilfred, Inc., engineers for the Fox Theater.

A. P. Davis Forced Out as Reclamation Director

Aim to Put Bureau on "Business Basis" Leads Secretary Work to Replace Engineer by Politician

Washington Correspondence

With the announced intention of placing the reclamation service in the hands of a business man, rather than an engineer, the Secretary of the Interior has summarily dismissed Arthur P. Davis from the directorship of that service. Mr. Davis is to be succeeded by D. W. Davis, former Governor of Idaho, who will serve under the title of "Commissioner of Reclamation". Former Governor Davis has been serving during the past year as special assistant secretary of the interior. A. P. Davis was chief engineer of the reclamation service from 1906 to 1914 and has been its director since 1914.

All the information Interior Secretary Work cares to make public concerning the change is that "we are going to put this branch of the Interior Department on a business basis, and operate it in the interest of the settlers on reclamation projects, as well as for the protection of the government. That's all there is to it." From other quarters, however, comes the intimation that the influence which resulted in the resignation of Director Davis has been contributed in part by those who oppose the repayment of the reclamation fund. With a good political lieutenant in a position where an exceptional opportunity to influence votes exists, a better chance would be offered the administration to counteract in the west the influence being exerted by Senator Borah, some say. They point to the President's stop at American Falls, as further proof that this is a part of the political campaign.

It is known positively that Director Davis' resignation was not voluntary. He is understood to have refused to be a party to the giving out of the impression that he is retiring from the position of his own volition. His position is said to be that he does not want to see the $132,000,000 investment represented by government reclamation projects endangered, by retiring at a time when the so-called repudiators are occupying such a position of vantage.

Washington Construction Program Approved by President

President Harding and all members of the cabinet have approved plans for a $20,000,000 construction program to house government departments in Washington. Partial approval also has been given plans for an omnibus public buildings bill at the next session of Congress to provide buildings, principally for the Post Office Department, in various sections of the country.

It is emphasized that buildings are needed in Washington so that departments and bureaus now in expensive leased quarters may be housed in structures owned by the government.

F. A. E. S. Executive Board Meets in St. Paul

Problems Discussed Include Traffic, Smoke Abatement, Water Supply, and City Planning

Traffic, smoke abatement, water supply, city planning, state and municipal legislation relating to engineering matters, reforestation and registration of engineers were outstanding topics at a recent meeting of the Executive Board of the Federated American Engineering Societies held in St. Paul, Minn. The meeting was characterized by an enthusiasm over the accomplishments of the Federation and an optimism over its program of activities.

Several committee reports were submitted. Among these was the Committee on Transportation which is considering ways and means whereby the Federation may be of useful service in relation to the general transportation problem of the nation. The authority to continue its study was given the Transportation Committee by the Board.

The Committee on Storage of Coal reported that it had met and perfected plans in Washington May 25. Subcommittees are now being formed in some eighty centers to undertake gathering of data which will enable the Federation to present accurate coal storage facts to the Federal Commission also studying the subject. Dean P. F. Walker of the University of Kansas, has been authorized by the Committee on the Storage of Coal to devote all of his time for the next few months to the work. He will visit various centers and assist the sub-committees in organization and then in execution of their respective tasks.

Registration Law Read

The committee appointed some months ago to prepare a proposed registration law for engineers submitted a tentative draft and the proposed bill was discussed at length. The committee was instructed, however, to rewrite the proposed bill, including certain valuable suggestions and constructive criticisms offered at the Board meeting, and report at the next meeting of the Board in October.

The Board gave much consideration to a communication from the Washington Society of Engineers requesting the Federation to develop plans whereby local engineering groups might take a more prominent part in comprehensive city planning. The Board recognized the importance of the suggestion and instructed the president and executive secretary to call the matter to the attention of the member societies for the purpose of encouraging greater activity in comprehensive metropolitan planning by local engineering groups.

The Board also gave consideration to the request from the Cleveland Engineering Society that the Federation support a movement to help Congress appoint a technical commission to make a thorough study of the engineering and economic phases of the proposed St. Lawrence waterway before making any definite decision on the project. The matter was referred to the Committee on Public Affairs for a thorough study and report.

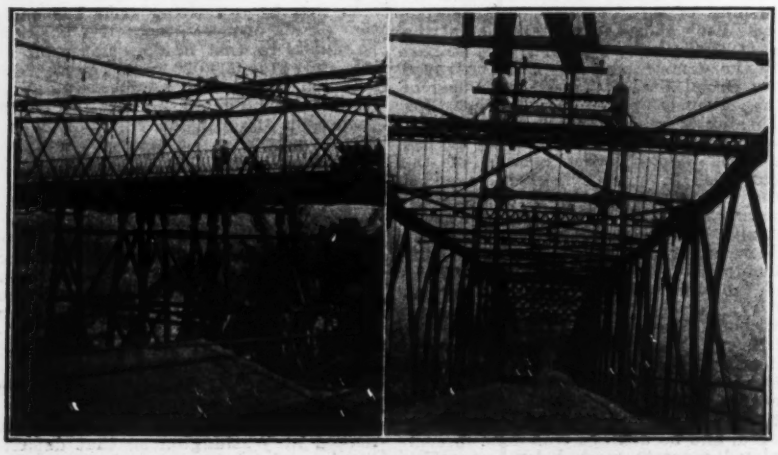
Reforestation Discussed

Reforestation was another subject discussed at length. As a result of the discussion the Board has requested the committee on that subject to submit at an early date a concrete plan of action, whereby the gospel of reforestation can be more effectively carried forward.

Among other action taken by the Board was a vote to participate in the World Power Conference to be held in London in 1924; acknowledgment of an invitation from the Association of Engineers and Architects of Czechoslovakia through the Czechoslovakian Minister at Washington for the Federation to send representatives to the annual meeting in Kasic, July 2-8; and the acceptance of an invitation from the Chamber of Commerce of Rochester, N. Y., to hold the October meeting there.

Members of the Executive Board were guests of the Engineers Society of St. Paul at dinner one evening during the session at which numerous prominent engineers spoke.

Shore Span of Steubenville Suspension Bridge



Temporary support of span, and buckled top chord of stiffening truss. For report of failure of the truss, see *Engineering News-Record* issue of May 31, p. 976.

Railroads Is Am.Soc.C.E. Convention Topic

Transportation and Terminals Will Compose Technical Program for Sessions in Chicago

The technical program of the fifty-third annual convention of the American Society of Civil Engineers to be held in Chicago July 11-13, will concern itself with railrorad transportation and railroad terminals. The symposium on railroad transportation will be held the morning of July 11 when the following speakers will discuss various phases of the problem: John W. Kendrick, consulting engineer, Chicago; John G. Sullivan, consulting engineer, Winnipeg, Canada; James R. Bibbins, consulting engineer, Washington, D. C.; Edwin F. Wendt, consulting engineer, Washington, D. C.; Charles A. Morse, president, Western Society of Engineers, Chicago; and John S. Worley, professor of railroad engineering, University of Michigan. Speakers on railroad terminals, a session to be held the morning of July 12, include H. R. Safford, Chicago, president of the Illinois Section of the Society; Alfred Fellheimer, consulting engineer and architect, New York; Charles E. Smith, consulting engineer, St. Louis; Jacob L. Crane, Jr., consulting engineer, Chicago; Daniel J. Brumley, chief engineer, Chicago Terminal Improvement, Illinois Central R.R.; Frederick E. Morrow, assistant chief engineer, Chicago and Western Indiana R.R., Chicago; Robert H. Ford, assistant chief engineer, Chicago, Rock Island and Pacific Ry., Chicago; J. D'Esposito, chief engineer, Chicago Union Station Co.; Rufus W. Putnam, Major, Corps of Engineers, U. S. A., Chicago; and William L. R. Haines, assistant engineer, Pennsylvania R.R., Pittsburgh.

Aside from the foregoing technical discussions there will be special meetings on the afternoon of July 11 of the Highway Division, Power Division and the Sanitary Engineering Division. Speakers who will address the Power Division will be W. L. Abbot, past-president of the Western Society of Engineers, and William T. Walker, superintendent of construction of the Minneapolis General Electric Co.

Inspection Trips Provided

Aside from the technical discussions there will be the usual social features as well as several inspection trips, which will include an automobile drive to the plant of the Universal Portland Cement Co. at Buffington, Ind., where luncheon will be served; a trip by automobile to the coal-gas and water-gas plant of the Chicago By-Product Coke Co.; a trip to the Calumet power station of the Commonwealth Edison Co.; a trip to the sewage treatment plants of the Sanitary District of Chicago; and an automobile drive given by the Chicago Engineers through the Chicago park and boulevard system, including Lincoln, Humboldt, Garfield, Douglas, Washington and Jackson Parks.

The program as a whole has been prepared under the direction of the Committee on Technical Activities and Publications, of which Richard L. Humphrey is chairman. The local committee of arrangement and reception is headed by Onward Bates, past-president of the Society, who is honorary chairman, and by H. R. Safford, chairman.

A. S. M. I. Meeting Place Changed from Memphis to Atlanta

Atlanta, Ga., has been substituted for Memphis, Tenn., as the place for the annual convention of the American Society for Municipal Improvements this fall. The transfer is due to changes in hotels at Memphis which make it impossible for them to care for the convention in accordance with arrangements which had been made. Charles C. Brown, St. Petersburg, Fla., secretary of the society, states that the date for the meeting at Atlanta will soon be announced, but that it will not be earlier than Nov. 12-16, the date set for the meeting at Memphis.

Flood Tops Oklahoma Dam

The main dam of the Oklahoma City waterworks, a hollow concrete dam 1,800 ft. long and 54 ft. high built in 1918, was overtopped a maximum of 16 in. for a period of 22 hours, June 13 and 14, by a rise in the Canadian River. No damage was done to the dam or embankments but nine pile bents in a highway bridge and five bents in an interurban railway bridge over the head of the by-pass channel were carried away. Two weeks before a hitherto unprecedented flood in the river was taken care of by the spillways which were designed for a flow of 16,000 sec-ft. The latest flood is estimated at 22,000 sec-ft. The embankment of the by-pass had been paved for 6,000 ft. with a combined wall and slab of reinforced gunite, as described in *Engineering News-Record*, May 17, 1923, p. 880. This stood up under the flood but about 3,000 ft. of unpaved section was threatened and saved only by sand bagging.

New York Central Increases Its Dividend

The New York Central R.R. has increased its stock dividend from the rate of 5 per cent, which it has paid continuously since 1908, to 7 per cent. The directors' statement at the time of the announcement of this increase said that since the consolidation of the New York Central and Lake Shore in 1914, the surplus had increased from $29,000,000 to over $112,000,000, that a large part of the company's capitalization is in long-term bonds bearing low interest rates averaging about 4.4 per cent, which with the new dividend rate of 7 per cent makes the return paid upon capital 5.07 per cent, without allowing for any return on reinvested surplus.

The New York Central now owns 95 per cent of the stock of the Michigan Central and 90 per cent of the stock of the Cleveland, Cincinnati, Chicago & St. Louis. These companies, as well as the parent company, are doing a large amount of business which will require additional capital to keep pace with its growth. Such additional capital should come at least in part from the sale of additional stock, and the stock of the company as well as its bonds must be made attractive to investors because future financing cannot be done to advantage on the basis of a constantly increasing debt and a stationary amount of stock. Following this announcement the railroad company made application to the I. C. C. for authority to issue $100,000,000 worth of new common stock.

Illinois Road Bill Is Passed

The Illinois Legislature has passed the bill providing for a bond issue of $100,000,000 for improved roads, but individual legislators tacked on so many amendments that the cost of the mileage listed in the bill is estimated at $174,000,000. This bond issue must be submitted to public vote in November, 1924.

Natural Gas Subject to the Laws of Interstate Commerce

A decree for the complainants, the States of Pennsylvania and Ohio, against the State of West Virginia was directed by the U. S. Supreme Court, June 11, in suits instituted to restrain West Virginia from putting into effect a law compelling natural gas companies to serve consumers within the borders of West Virginia in preference to those outside that state, in the case of gas taken from within the state.

The decision was by a divided court, Associate Justices Holmes, McReynolds and Brandeis dissenting from the majority opinion, which was read by Associate Justice Van Devanter.

The majority opinion held that the West Virginia law was in violation of the Interstate Commerce clause of the Constitution. West Virginia had invited capital into the state to develop natural gas and had encouraged corporations to enter interstate business in this fuel. To cut off a supply to consumers in other states when the supply runs short, as the West Virginia act would compel, would mean a hardship to the interstate consumers, the opinion held.

The three dissenting justices held that West Virginia legally had the right to regulate the product because it does not assume interstate character until it is sent out of the state. Justice Brandeis held that the most the Supreme Court should do would be to compel the West Virginia gas companies to give the West Virginia customers at least as good service as those outside the state.

Philadelphia Bridge Anchorage Caissons Reach Bottom

One of the circular caissons of the west anchorage of the Philadelphia-Camden suspension bridge reached sound rock and was sealed on June 11. A second one was sealed on June 14. The two reached elevations of 64 and 62 ft., respectively, below city datum. These, as well as the rectangular caissons which form the forward wings of the anchorage, are being sunk by open dredging. Work is in progress on the south rectangular caisson, which is down to El. -55, but some delay is being experienced in dealing with the sloping rock surface.

The circular caissons reached bottom after a heavy chisel bar was used to break out the rock in the central part of the shaft, and the weight of the caisson then forced it down into the soft upper strata of the rock tightly enough so that it could be pumped out. The outer rim of rock was then cut down several feet to the sound schist, and the caisson sealed. It was not necessary to bulkhead the shaft and bottom the caisson under compressed air, although provision is made in the construction of the caisson for this.

In the case of the rectangular caisson, 40 x 125 ft., the slope of the rock is downward from west to east in the direction of the caisson length, and it will be necessary to excavate the rock at the west end to permit of bottoming the caissons at the seat end. By partially filling the easterly pockets the contact is made tight enough to permit of pumping down the westerly pockets, and it is hoped to be able to carry out the required excavation under open air.

Reproduction Cost Theory Subject of Two Opinions

Supreme Court Issues Two Additional Decisions Regarding Theory for Rate Making Purposes

Washington Correspondence

Two cases involving questions of evaluation of a public utility for rate-making purposes, particularly the reproduction-cost-new theory of value, were decided by the United States Supreme Court June 11.

In the case of the Bluefield Water Works & Improvement Co. against the Public Service Commission of West Virginia, the court, in an opinion by Associate Justice Butler, held that the rates fixed for water service at Bluefield were too low, because on a reproduction less depreciation value the return was only 6 per cent, which the court deemed insufficient. Associate Justice Brandeis agreed with the other members of the court in reversing the state court, but noted the same position regarding replacement values that he took in the case of the Southwestern Telephone Co. against the Missouri Commission. (*Engineering News-Record*, June 7, 1923, p. 1010.)

The Public Service Commission fixed the water rates in 1920. The company declared the rates inadequate and confiscatory and applied to the State Supreme Court of Appeals for a suspension of the order. The company alleged the value of its property to be greatly in excess of that fixed by the Public Service Commission and complained that the commission did not allow for increased costs of replacement between 1915 and 1920. The state court denied the relief sought.

In the case of the Georgia Railway & Power Co. and the Atlanta Gas Light Co., its lessor, the supreme court, in an opinion read by Associate Justice Brandeis, affirmed the decree of the lower courts dismissing a suit against the Railroad Commission of Georgia to restrain reduced rates for Atlanta's gas supply. Associate Justice McKenna dissented from the majority opinion, holding that replacement value, as fixed in principle by the court in the cases of the Southwestern Telephone Co. and the Bluefield Water Works & Improvement Co., had not been applied in this Georgia case.

The majority opinion pointed out that in the Atlanta gas case, the Railroad Commission had carefully considered replacement value and increased costs, although it did not allow all the claims of the company in this regard.

The court also approved the finding of the Georgia Railroad Commission that "present fair value" is not synonymous with "present replacement cost," particularly under abnormal conditions.

Random Lines

Extracts from an Outline of Engineering

CONCRETE

Some stone, some highly standardized cement,
Sand of just the proper size of grains,
Water to wet; then add one element,
A dash of an abused ingredient—brains.

SEWAGE DISPOSAL

Screen out the rough stuff, turn over the goo
To the bugs with such appetites low;
Let it settle and stew and bubble and brew;
But what to do with the sludge—we don't know.

* * *

A Word in Protest

This is the time of the year when it is customary to depict the new college graduate as going forth to offer his services at nothing less than president or general manager, satisfied that his ability and training are too great for any ordinary job. Never was there baser fabrication. Most college graduates approach commencement with feelings made up of amazement at the fact that they have really managed to pull through, of thankfulness for the luck which through four years presented to them questions they were able to answer within the limits of failure allowed, and of awe at the vast areas of knowledge and experience they have never traversed. Down in their hearts they wonder that any one would have them for any job, much less an important one. If a college education does not teach humility it isn't good for much.

* * *

The 18th amendment has its compensations. Now comes a "brewery engineer"—representing a once lucrative and doubtless useful branch of the profession—with a proposition to build, for obvious uses, an island 3+ miles out from Sandy Hook. The proposal involves novel developments in long extension cylinder piles which foreshadow, the "brewery engineer" says, little islands dotting the transatlantic route, a boon to the seasick and the bridge builder alike. Out of evil oft comes good.

* * *

Not Knocking Newspaper Men

"I have explained the construction," says an engineer describing a new project in a recent newspaper article, "so not only the engineer but the layman can understand how plain and simple it is once you know how to do it. Even the newspaper men should understand this explanation, at least a part of it."

* * *

Street car conductors in Los Angeles, we learn, are prohibited by ordinance "from shooting live game—notably jack-rabbits—from the platforms." Now if they would only declare an open season on automobilists the traffic jam on Broadway might be speedily cleared up.

State to Build Poughkeepsie Bridge; Moran and Modjeski Engineers

Construction of a bridge across the Hudson River at Poughkeepsie as a state enterprise has been provided for by the state legislature of New York in a bill just approved by the governor. An appropriation of $200,000 is made in the bill for the preparation of plans and survey data. The work has been placed in charge of state highway commissioner Frederick Stuart Greene, who has engaged Daniel E. Moran and Ralph Modjeski as consulting engineers for the bridge.

It is not yet known what type of bridge will be determined upon or precisely what location will be adopted. The act leaves the location open within wide limits. It is believed possible that a suspension type of structure may be designed, the depth of rock being 140 to 150 ft.

The city of Poughkeepsie will provide land for the east approach, and a private owner has donated right-of-way for the west approach.

Plans for a bridge at Poughkeepsie were prepared a year ago by Henry Goldmark and Gen. George W. Goethals. They provided for a cantilever structure of five main spans, as illustrated in *Engineering News-Record* of Dec. 21, 1922, p. 1090. It is stated by the highway commissioner that the bridge is likely to cost about $5,000,000. With the best possible progress it is expected that foundations might be constructed during 1924 and 1925, and the superstructure erected during the following year, but the actual period of construction is likely to be longer. A change of administration or failure of the legislature to make appropriation for the continuance of the work would be likely to interfere with rapid construction, however.

Authority is given in the bill for charging tolls for traffic across the bridge, and the maximum amounts of toll are specified. Collection of tolls is to cease in any event when the revenues, less the expenses of maintenance and operation, shall equal the cost of the bridge.

Los Angeles Approves Bond Issues Totaling $26,500,000

At an election in Los Angeles on June 5 voters of that city approved by a two-thirds vote five out of six proposed bond issues. The issues that carried were as follows: (1) For the purchase of site and erection of a city hall, $7,500,000; (2) for the purchase of land needed for an extension to the Public Library, $500,000; (3) harbor improvement bonds, $15,000,000; (4) for construction of viaduct over Los Angeles river and the railroads paralleling it, $2,000,000; and (5) for public playgrounds, $1,500,000.

The sixth proposition was for a bond issue of $35,000,000 of which $10,000,000 would have been for improvement and extension of the present municipal electric power network within the city and $25,000,000 for the development of hydro-electric power at the Boulder Canyon on the Colorado River including the transmission of that power to the city. Although this sixth proposition did not receive the two-thirds vote necessary to carry it, it did get a majority.

U. S. High Tribunal Curbs Kansas Industrial Court

Taft Opinion Declares State Has No Right to Regulate Wages Not of Public Interest Character

On June 11 the United States Supreme Court rendered a unanimous decision seriously restricting the scope of the Kansas Court of Industrial Relations. In the case at issue, the secretary of the Meat Cutters' Union in January, 1921, appealed to the Industrial Court against a reduction in wages by the Charles Wolff Packing Co. A hearing was held and the court ordered that wages be advanced beyond the scale fixed by the company, asserting that an emergency existed and that higher wages were in the public interest as the plant produced food. The company resisted payment of the higher wages and the industrial court applied to the state supreme court for a mandamus to compel compliance with its order. A commissioner appointed by the state supreme court reported that the company had lost $100,000 the previous year and that the evidence did not support the claim that an emergency existed. The state supreme court overruled this report by the commissioner and issued the mandamus, whereupon the company applied to the United States Supreme Court for a writ of error, alleging its property would be taken without due process of law.

In his decision, Chief Justice Taft said:

"It [the act creating the industrial court] curtails the right of the employer on the one hand and of the employee on the other to contract about his affairs. This is part of the liberty of the individual protected by the guarantee of the due process clause of the Fourteenth Amendment. . . .

"It has never been supposed, since the adoption of the Constitution, that the business of the butcher, or the baker, the tailor, the wood chopper, the mining operator or the miner was clothed with such a public interest that the price of his product or his wages could be fixed by State regulation. . . . To say that a business is clothed with a public interest is not to import that the public may take over its entire management and run it at the expense of the owner. The extent to which regulation may reasonably go varies with different kinds of business. The regulation of rates to avoid monopoly is one thing. The regulation of wages is another.

"We think the industrial court act, in so far as it permits the fixing of wages in plaintiff in error's packing house is in conflict with the Fourteenth Amendment and deprives it of its property and liberty of contact without due process of law."

Ford Granted High Dam License

A license extending to Henry Ford the right to utilize the High Dam on the Mississippi River at St. Paul, for a period of fifty years, has been executed finally by the Federal Power Commission. The license covers the construction of a power house on the existing substructure at the St. Paul end of the dam. The power house will be equipped with four turbo-generating units, each with a capacity of 4,500 kva.

Engineering Societies

Calendar

Annual Meetings

AMERICAN SOCIETY FOR TESTING MATERIALS, Philadelphia; Annual Meeting, Atlantic City, N. J., June 25-29.

AMERICAN SOCIETY OF CIVIL ENGINEERS, New York, Annual Convention, Chicago, July 11-13.

NEW ENGLAND WATER WORKS ASSOCIATION, Boston, Mass.; Annual Convention, Burlington, Vt., Sept. 18-21, 1923.

AMERICAN PUBLIC HEALTH ASSOCIATION, New York; Annual Meeting, Boston, Oct. 8-11.

The American Society of Civil Engineers at its meeting at New York June 13, heard a paper on the disintegration of cement in sea water, presented by William G. Atwood, Director, and A. A. Johnson, Assistant Director of the Committee on Marine Piling Investigations, National Research Council. The purpose of the paper was to place before the engineering profession a history of the study of cement for use in sea water, and an analysis of the results obtained. The paper is to be published in the August *Proceedings*. The discussion which followed the presentation of the paper was largely devoted to the effect of acid waters and fresh water on concrete rather than actual sea water.

Personal Notes

WILLIAM S. MENDEN, who has been chief engineer of the Brooklyn Rapid Transit Co. since 1905, has been made president of the company, the name of which, upon the closing of the receivership and dismissal of the receiver, has become the Brooklyn-Manhattan Transit Co. Mr. Menden was born in Evansville, Ind., in 1868 and graduated from Rose Polytechnic Institute as a civil engineer. From 1891 to 1905 he was successively rodman, assistant engineer on construction, and chief engineer in charge of construction and maintenance, Metropolitan West Side Elevated R.R. Co., Chicago.

RALPH N. BEGIEN, general manager of the Baltimore & Ohio R.R., Western Lines, has been appointed operating vice-president of the Chesapeake & Ohio, with headquarters at Richmond, Va. Mr. Begien's early work, after graduation from Harvard in 1897, was largely in the tropics, where he spent three years with the Nicaragua Canal Commission and one on railroad work in Ecuador. He entered the employ of the Baltimore & Ohio as assistant engineer in 1902. In 1908 he was made division engineer. Two years later Mr. Begien became assistant to the chief engineer. In 1912 he was appointed assistant general superintendent of the main-line system and later general superintendent of the Baltimore & Ohio Southwestern. He was made general manager of the B. & O. Eastern lines in 1917, having previously served the road as chief engineer.

ALLEN W. STEPHENS, of the Turner Construction Co., New York City, was awarded the honorary degree of Master of Science at this year's commencement of the University of Maine. Mr. Stephens is a graduate in civil engineering from that university and is president of the General Alumni Association.

GERARD SWOPE, president of the General Electric Co., was awarded the degree of Doctor of Science at Rutgers College on June 12. DR. IRVING LANGMUIR, assistant director of the research laboratory of the company, received the degree of Doctor of Science from Union College, Schenectady; and DAVID B. RUSHMORE, consulting engineer, a D.S. degree from his alma mater, Swarthmore College. All of these men have been intensely interested in furthering scientific education in our colleges and schools and have taken a leading part in the forward looking movement of co-operation between the colleges and industry.

CHARLES G. DUVALL, chief inspector in the Indianapolis city engineering department, will resign soon to become superintendent of construction for the Union Asphalt Paving Co.

CHESLEY GRAY, chief engineer of the Indiana state highway commission, has been given a civil engineering degree by Rose Polytechnic Institute, Terre Haute, Ind., of which he is a graduate, the degree being granted on his professional record.

PRATT-THOMPSON CONSTRUCTION CO. announce the removal of their general offices to 114 Tenth St., Kansas City.

J. DI STASIO, formerly chief engineer of the Fougner Concrete Steel Co., and U. T. BERG, reinforced concrete specialist, announce their association as J. DI STASIO & CO., consulting engineers, New York City, specializing in reinforced-concrete structures.

CHARLES T. PHILLIPS, consulting engineer, has opened offices in Los Angeles, Calif., under the firm name of the Charles T. Phillips Co., consulting engineers, having associated with him Arthur Kempston, former chief of the department of electricity in San Francisco, and Fred B. McNally, mechanical engineer, formerly of Fresno. The new firm will specialize in plans, specifications, tests for fire alarm systems, street lighting and power plants.

WILLIAM S. MURRAY, consulting engineer, New York City, formerly consulting engineer of the New York, New Haven & Hartford R.R., received the degree of Doctor of Engineering at Lehigh University, last week, where he also delivered the alumni address.

WILLIAM C. MARKHAM, construction engineer for the Detroit street railways, has resigned to become treasurer and general manager of W. C. Markham & Co., a firm affiliated with eastern interests, for general construction work. Mr. Markham has served in the Detroit department of street railways since the beginning of municipal ownership in 1920.

PROF. W. K. HATT, Director of the Advisory Board on Highway Research, National Research Council, has returned from Europe, and will resume his duties in Washington, D. C.

A. L. FERVER, city engineer and director of the department of public service for the city of Long Beach, Calif., has resigned, effective June 15.

JOHN N. EDY, former chief engineer of the Montana State Highway Commission, will be the first city manager of Berkeley, Calif., and will assume office July 1 under provisions of the city's recently adopted charter.

GEORGE W. GOETHALS & CO., consulting engineers, New York City, has been dissolved by mutual consent of the stockholders. General Goethals continues the practice of engineering at the old address, 40 Wall St.

HENRY C. TURNER, president of the Turner Construction Co., of New York, was awarded the honorary degree of Doctor of Engineering on June 11 by Swarthmore College, from which he graduated with a degree of B.S. in 1893. Mr. Turner is one of the pioneers in the building of reinforced concrete in this country. He joined E. L. Ransome in 1900 and for two years was associated with him in developing the then new art of reinforced concrete. In 1902, in company with DeForest H. Dixon, also with Mr. Ransome, he formed the company of which he is president and which has built some of the largest reinforced-concrete buildings in the country. Mr. Turner was president of the American Concrete Institute for two years. He received the degree of civil engineer from Swarthmore in 1903.

Obituary

CLYDE M. CARR, president for 12 years of the iron, steel and machinery firm of Joseph T. Ryerson & Son, Inc., Chicago, died June 5. On account of poor health he had been unable to take an active part in the management of the firm for the past four years and last January resigned as president, although continuing until the time of his death as a member of the board of directors. Joseph T. Ryerson succeeded Mr. Carr to the presidency. Mr. Carr became associated with the Ryerson organization in 1890.

L. B. YOUNGS, for 28 years head of the water department of Seattle, Wash., and for ten years chairman of the Board of Public Works, died suddenly June 10, stricken with heart failure. Mr. Youngs became head of Seattle's water and light department in 1895. When the departments were separated in 1910, he remained as superintendent of the water department, and under his supervision the department has grown to a great public utility. Mr. Youngs was born in Fulton, Kentucky, in 1859, and has resided in Seattle for 35 years.

CHARLES R. SEABROOK, of Owen & Seabrook, Detroit, Mich., died in that city recently. Before joining this firm, Mr. Seabrook was chief engineer for H. M. Lane Co., industrial engineers, Detroit, and structural engineer for the Chile Exploration Co., Chuquicamata, Chile. He served during the War in the Air Nitrates Division of the Ordnance Department.

DR. LOUIS BELL, consulting electrical engineer, authority on power transmission, and former editor of *Electrical World*, died at his Boston home June 14, aged 58. Dr. Bell, a graduate of Dartmouth, received his Ph.D. at Johns Hopkins. For many years he was with the General Electric Co. He was the author of numerous technical books.

From the Manufacturer's Point of View

A Point of Contact Between Maker and User of Construction Equipment and Materials

Discuss Standardization of Concrete Mixers

To consider the possibilities of standardization in the concrete mixer field a meeting was held at Cleveland last month at which were present representatives of the Associated General Contractors of America, mixer manufacturers and engineers. It was agreed that the question of standardizing mixers should be submitted to the makers of that line of equipment. The meeting is in line with the program of the Joint Conference of Equipment Manufacturers and the A.G.C. initiated last fall when a standardization steering committee, headed by Brig.-Gen. R. C. Marshall, Jr., general manager of the contractors' association, was appointed.

At the Cleveland conference it was recommended that the entire standardization procedure be tied in officially with the American Engineering Standards Committee, and that all mixer manufacturers be invited to attend a meeting for the purpose of making recommendations and, if possible, starting the work. This meeting will, in all probability, be held in Chicago at an early date.

Plan New Research on Electric Steel Foundry Problems

The Electric Steel Founders' Research Group held a regular meeting of executives of the five electric steel foundries conducting cooperative research work, at Wernersville, Pa., May 14-17. The companies represented were the Electric Steel Co., Chicago, Fort Pitt Steel Casting Co., McKeesport, Pa., Lebanon Steel Foundry, Lebanon, Pa., Michigan Steel Casting Co., Detroit, and Sivyer Steel Casting Co., Milwaukee.

Research work being done by the members of the group to improve the quality of steel castings and increase efficiency in methods were discussed and formal reports gave the status of research investigations on facing sand mixtures, core sand mixtures, electric furnace practice, heat treatment of steel castings, production control, and porosity in castings.

Plans were made for conducting research investigations on additional steel foundry problems.

Construction Equipment Exported

Figures for March, 1923, from the U. S. Department of Commerce indicate the following exports of American construction equipment: 13 power shovels, valued at $177,091; 7 cranes, at $59,785; 23 concrete mixers, at $25,129; about 274,000 lb. of dredging machinery at $45,536; about 251,000 lb. of miscellaneous road-building equipment, at $36,251.

Of the power shovels, Japan took 6 at $89,096. Six concrete mixers at $10,310 were shipped to Mexico. Egypt paid $41,935 for miscellaneous construction equipment.

Propose Two Grades for Hard Pine and Fir Timbers

Two grades for structural timbers of Southern pine and Douglas fir have been adopted by the consulting committee on lumber standards of the National Lumber Manufacturers' Association, on the recommendation of a sub-committee. The two grades are Standard and Common. Standard is to include what has been known as merchantable long leaf in Southern pine (which itself was of different actual quality at different delivery points), and selected common in Douglas fir. Common is to include those grades designated as square edge and sound and No. 1 common in Southern pine, and No. 1 common in Douglas fir. Defect specifications as formulated by the Forest Products Laboratory for "select" grade are to be used. Working stresses are to range from 1,250 to 1,750 depending on the density of the material. These figures are for material used under shelter; material in exposed locations is to be limited to stresses 200 lb. lower.

Air Consumption of Pneumatic Tools Estimated

To aid in the selection of air-compressor outfits of the proper size, the Novo Engine Co., Lansing, Mich., has prepared the following table showing the air consumption in cubic feet of free air per minute for the various pneumatic tools commonly used in construction work.

Tool	Cu.ft. Free Air per Min.
Heavy riveting hammers	20–25
Chipping and calking hammers	15–20
Small air drills (metal or wood work)	15–20
Medium air drills (metal or wood work)	25–35
Heavy drills and reamers	35–55
Stone tools for lettering and bushing work on granite and marble	4–6
Blacksmith forges	6–10
Air paint brushes	5
Plug drills for stone quarry work	20
Rotating drills of jack-hammer type	50–70
Paving breakers	53–65
Clay diggers	35–40

In explanation of the table the company points out that while ratings for air compressors are in displacement of cubic feet of free air per minute, this is a more or less arbitrary standard in that the amount of delivered air always varies with the pressure and temperature. It is characteristic of all air compressors that they do not deliver the full amount of air they displace.

Pump, Shipped by Truck, Supplies Paver When City Water Fails

Requiring a round trip by motor truck of 400 miles between job and factory, a portable pumping plant rushed to the road contract of Reith & Riley in Kankakee, Ill., prevented a long shutdown of the work due to failure of the water supply from the city main. When this condition occurred the contractors immediately ordered a Quad 44 pumping plant from the Barnes Manufacturing Co. and in order to forestall the possibility of delay by freight shipment, sent their Reo speed wagon to the factory at Mansfield, Ohio for the pump. The equipment, weighing 5,000 lb., was loaded on the truck at Mansfield on the afternoon of May 15 and reached Kankakee, a distance of more than 200 miles, on the afternoon of the 17th. The pump was put into service the following day and since that time has been supplying water to the 21-E paving mixer used on the road contract.

Business Notes

DORR CO. has moved to new offices in New York and opened an office in Los Angeles, Calif., in charge of Alfred T. Hastings. The company manufactures water softening and clarifying equipment.

COMPLETE MACHINERY & EQUIPMENT CO., New York, has recently been organized to handle contractors' equipment. The principals in the new concern are F. H. Rothschild and B. Share, formerly superintendent of the E. George Co.

WHEELING STEEL PRODUCTS CO., Wheeling, W. Va., sales company for the LaBelle Iron Works, Whitaker-Glessner Co. and Wheeling Steel & Iron Co., discontinued May 1, 1923, and the Wheeling Steel Corp. is now handling all sales and operations. The Wheeling Steel Corp. assumes all existing sales obligations of the Wheeling Steel Products Co., and of the three companies above named. This action will not affect the personnel of the sales division which will remain unchanged at Wheeling and at district sales offices.

LINK-BELT CO., Chicago and Philadelphia, announces that L. M. Dalton has succeeded E. J. Burnell as manager of the Boston branch office. Mr. Burnell resigned to enter business for himself.

WESTINGHOUSE ELECTRIC & MANUFACTURING CO., East Pittsburgh, Pa., announces the following changes in personnel: Because of the increasing importance of business in the foreign countries T. E. Simpers, formerly manager of the general mill section of the industrial department, has been appointed export representative of the industrial department. This is a new position made necessary by the large size to which the foreign business of the industrial department has grown. For the present J. R. Olnhausen will have supervision over the industries formerly under the control of Mr. Simpers.

MIDWEST ENGINE CORP., Indianapolis, announces that in addition to the manufacture of its regular line of gasoline engines it will undertake the reconditioning of freight cars and railway locomotives. This work will be done in portions of the plant which have been idle since the company discontinued its war contracts.

PELTON WATER WHEEL CO. has acquired additional property near its present San Francisco plant and will begin extensions at once that will practically double its manufacturing facilities. A modern two-story structure 115 x 200 ft. in plan is to be built to serve as office, drafting room, pattern shop and pump assembly department.

This structure is estimated to cost about $500,000. When the several departments can be moved into it there will be made available in the old plant space which is needed for the installation of new equipment and the enlarging of the turbine erecting department.

GIFFORD-WOOD CO., manufacturer of elevating and conveying machinery, Hudson, N. Y., announces the removal of its Buffalo office to Pittsburgh, effective May 1.

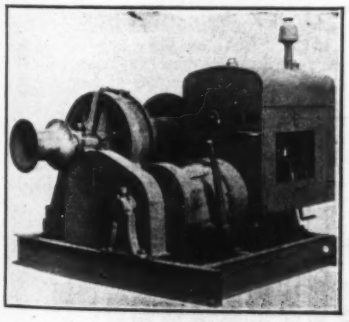
COPPER & BRASS RESEARCH ASSOCIATION, New York, has just added to its membership the Engels Copper Mining Co., Gransby Consolidated Mining, Smelting & Power Co., Dallas Brass & Copper Co., Merchants & Evans Co., T. E. Conklin Brass & Copper Co., J. M. & L. A. Osborn Co., and Richards & Co., Ltd., the present membership of the association being comprised of 26 copper mining companies and 15 copper and brass fabricating and distributing companies. Information has just been received by the American association of the formation in England of a similar organization, the Copper and Brass Extended Uses Council.

Equipment and Materials

Gasoline Hoists Have Improved Thrust Apparatus

One of the features of the single- and double-drum gasoline hoisting units manufactured by the Domestic Engine & Pump Co., Shippensburg, Pa., is an improved thrust apparatus. This consists of a heavy steel screw and yoke which pushes against the hub of the drum through a thrust bearing consisting of two hardened and ground steel plates with bronze plate between. The screw also pulls the drum out of engagement by a positive movement, no spring being used to push the drum away from the friction. This design, the manufacturers point out, obviates any possibility of the friction sticking and gives the operator absolute control of the load.

The hoists are designed for a load

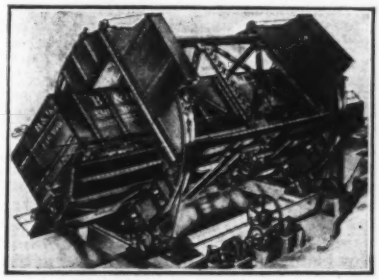


of 2,000 lb. on a single line at 150 ft. per minute rope speed. The units are mounted on heavy frames of steel channels thus insuring rigid foundation and true alignment of engine and hoist. The brakes are of the band type with toggles to foot levers, while the drum frictions are of the cone type. To each drum shaft is attached a winch head. A lever within reach of the operator changes the engine speed so that slow or fast speeds can be obtained.

Cable-Operated Car Dumper

A new car-dumping machine for unloading coal from gondola cars has been designed by the Link Belt Co., Chicago, and the first machine is being built for a power plant at East St. Louis, Ill. The revolving cradle in which the car is placed is a structural steel frame with two trunnion rings which rest on rollers in the substructure. One of the rollers is flanged to prevent endwise shifting of the cradle. These rings are spaced so as to give supports approximately under the trucks of the car and thus minimize bending stresses. The cradle is balanced to require a minimum of power and is operated by a pair of cables. Each cable is wound on a motor-driven drum and has its ends attached to opposite sides of the trunnion ring. This arrangement dispenses with gears and racks. No end clamps are needed and the car does not have to be spotted in exact position.

In the cradle the car rests on a deck which is supported by rollers in the main frame and tends to shift the car laterally against the dumping side of the cradle, where it is supported for

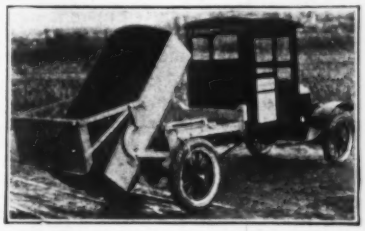


its entire length. Automatic motor-driven clamps then come down to a bearing upon the car for its entire length. When the car has a bearing against the side of the dumper, a switch is engaged and the motor operating the top clamps is automatically started, applying the clamps through cable loops and a differential drive, which insures equal pressure on all clamps. This motor is stopped by means of pressure-operated limit switches which cut out the motor when a predetermined pressure is applied to the clamps. If this pressure should be decreased, as by the breaking of a lump of material between car and clamps, the motor will again be put in operation until pressure is restored. The main or rotating motor can then be operated, but if the clamps are not applied at the proper time, a limit switch will cut out the rotating motor, thus stopping the dumping operation until the clamps are again made operative. Limit switches stop the dumping at the proper time.

When the car is unloaded, the operator reverses the rotating motor. While the cradle is returning to its normal position, the clamp motor is automatically reversed by a switch on the machine and the top clamps are then released by means of a counterweight. The shifting deck on which the car is supported is pushed into alignment with the fixed rails at the ends of the dumper, and the empty car is pushed out by the next entering loaded car. Only one electric controller is required for all operations.

All-Service Body for 1-Ton Truck

An all-service body which can be fitted to a 1-ton truck chassis and is more particularly designed for the Ford has been placed on the market by the New York Central Iron Works Co., Hagerstown, Md. The body, known as the Crooke, measures 72 x 44 x 20 in.



and has a capacity (without surcharge) of 36½ cu.ft. It is of all-steel construction and may be attached to the chassis by six bolts without drilling. The dumping operation is effected by a hand-operated crank at either side; at no time is the load lifted. The equipment, its manufacturers claim, combines the advantages of bodies of the slow-dumping and quick-dumping type.

The body is adapted to a wide variety of uses. In handling coal the tail gate is inoperative, so that the flow of material to a chute may be controlled by a vertical sliding grate. For express purposes, such as the handling of lumber and building supplies, the tail-gate may be disconnected and thrown over to the front end of the body, producing an open-end truck. For road contract work and the handling of sand, gravel and brick the tail gate opens automatically during dumping operations, as shown in the accompanying photograph, and closes with the return of the body to its normal position. Spreading of material may be done by partially tilting the body.

Leadized Non-Corrosive Steel

Protecting steel pipes and plates against corrosion by the application of a lead coating as an integral part of the steel is a process known as "leadizing" which is being introduced by the Leadizing Co., Chicago, and is the invention of R. J. Shoemaker. The cost of the "leadized" steel is said to be little more than that of plain wrought-iron, which is often advocated on account of its high resistance to corrosion. Further, an advantage is claimed over galvanizing in that the latter gives only a surface coating which may flake off when the metal is bent or struck and which is not proof against sulphuric acid fumes, while the lead coat is homogeneous with the steel and will resist this acid.

Piping at railway shops and roundhouses, factories, mines and power plants is liable to corrosion from sulphuric acid in smoke, from the chemical action of cinders in which piping is laid in floors and yards, and from the chemical action of certain waters. In the hot treatment, the material to be coated is immersed in molten lead. In the cold treatment the lead is deposited by chemical reaction. The former method was developed while the inventor was with the Atchison, Topeka & Santa Fe Ry., and it is stated that leadized pipe buried in cinders at the Topeka shops in 1917 was in perfect condition after several years' service.

Optical Contour Projector

A projecting lamp which will project onto a screen or a measuring plate the exact contour of an object has been devised by the Bausch & Lomb Optical Co., of Rochester. The projected image is greatly enlarged, according to a description of the device by H. F. Kurtz before the Rochester Engineering Society recently. Screw threads or gear contacts may be projected upon a screen by this device and observation of the action or measurement of details carried out.

Publications from the Construction Industry

Portable Air Compressors — NOVO ENGINE CO., Lansing, Mich., in an 11-p. illustrated bulletin presents data on a variety of portable air-compressor outfits. The compressors are of the duplex, single-stage, single-acting vertical type, designed to operate against pressures up to 100 lb. per square inch. These compressed-air outfits are intended for operating rock drills, paint-spraying machines, boring machines, riveters, air hoists, and calking tools. Among the distinctive features noted by the manufacturer are the short belt drive and individual tooling systems for both engine and compressor, enabling the former to be used as an independent power plant.

Oil-Burning Equipment — COMBUSTION ENGINEERING CORP., New York, has published a new catalog which is characterized as a complete treatise on the subject of oil burning. Information is given on the properties, specifications, advantages, and supply of fuel oil, followed by a description of the Quinn oil-burner. One chapter deals with a comparison of the operating and equipment costs for oil and coal. The concluding portion of the text takes up important points in the installation of oil-burning systems and the combustion of fuel oil.

Portable and Permanent Buildings— KOLB BUILDING CO., INC., New York, devotes 64 p. in a newly published illustrated catalog to its portable and permanent buildings. While much of the information relates to residences, the company includes in its line of wooden structures, contractors' field offices, checkers' booths both for piers and freight yards, construction camp buildings, including administration buildings, restaurants, dormitories and barns. Several types of small portable all-steel storage buildings are illustrated.

Wire and Iron Fences — BUCKEYE WIRE & IRON WORKS CO., Columbus, Ohio, describes its plain and ornamental wire and iron work for fences, window grating, and elevator cages and shafts in a 31-p. illustrated catalog.

Gyratory Crushers—AUSTIN MANUFACTURING Co., Chicago, has issued a 14-p. illustrated bulletin dealing with its portable gyratory crushing and screening plants. Among the new features of this line of equipment is a portable gravel feeding conveyor, made in lengths of from 30 to 50 ft. with a belt 18 in. wide. The company's No. 4 crusher is now mounted on substantial wheel trucks and can be moved from place to place by the traction engine used to drive the crushing plant.

Water Main Cleaning—NATIONAL WATER MAIN CLEANING CO., New York, has just published a booklet listing, alphabetically, cities in which it has cleaned pipe.

Business Side of Construction

FACTS AND EVENTS THAT AFFECT COST AND VOLUME

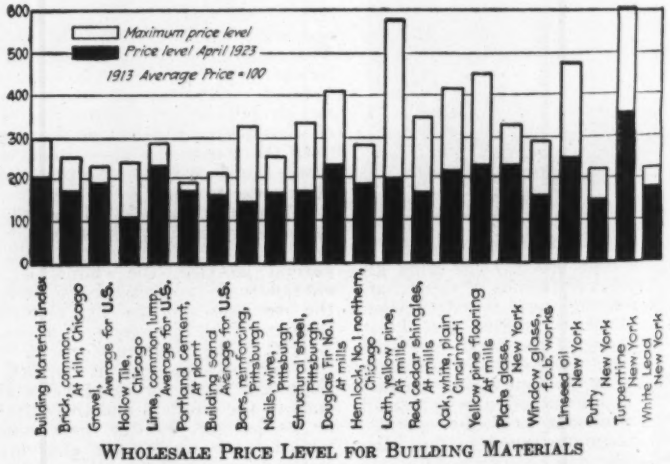
Lumber Shipments Decline

Lumber shipments from the mills during the week which ended May 19 showed a further decline, according to the weekly lumber movement review of the National Lumber Manufacturers' Association. For the week ended May 19 shipments reported from 385 mills were 237,000,000 ft., as compared with 255,000,000 ft. the previous week from 415 mills. The volume of new business accepted has been declining for some time, being 208,000,000 for 385 mills, as compared to 224,000,000 for 415 mills, —less than last year at the same time. Production, however, continues larger than last year by 21,000,000 ft. However, for the year to date shipments, orders and production are well ahead of last year, which was itself an exceptionally active year.

Owing to the extraordinarily large volume of business handled during the winter months when the lumber trade is usually lethargic, the customary succession of seasonal action and reaction in the industry has been upset this year, so that comparisons between corresponding periods of this year and last may not reflect the general state of the trade. It is likely, however, that the rising costs of building and the effort now being made to defer building activity for the purpose of stabilizing building costs, is already having some effect. Such deferment is largely, however, in the larger construction projects. Suburban and residential building activity continues with little diminishment.

Wholesale Prices of Building Materials for April, 1923

The accompanying chart shows the April, 1923, wholesale price level for building materials based on statistics gathered by the Bureau of Labor. The 1913 average price is taken as 100 on the scale and the maximum as well as the April index numbers are indicated.



WHOLESALE PRICE LEVEL FOR BUILDING MATERIALS

Southern Ry. Buys Rail to Improve Its Lines

Thirty-three thousand tons of steel rail have just been purchased by the Southern Railway System for delivery during the last six months of 1923. Included in this order are 25,500 tons of 100-lb. section and 7,500 tons of 85-lb. section rail. This brings the Southern's purchase of new steel for 1923 to 73,000 tons, 40,000 tons having been bought earlier in the year. The 100-lb. rail will be used in carrying out the program of the Southern to relay the Washington-Atlanta, Cincinnati-Chattanooga, and other lines of high traffic density with this heavy rail. The work is now in progress.

The largest share of the new order went to the Tennessee Coal, Iron & Railroad Co., which will roll 23,000 tons at its Ensley, Ala., plant; 8,000 tons were ordered from the Bethlehem Steel Co., and 2,000 tons from the Illinois Steel Co.

Portland Cement Production Shows Gain

The following statistics from tables issued by the Department of the Interior and prepared under the direction of Ernest F. Burchard, of the Geological Survey, are based mainly on reports of producers of portland cement, but in part on estimates.

During April, 1923, production totaled 11,359,000 bbl. as against 9,243,000 bbl. for the same month last year; shipments this April were 12,954,000 bbl. as against 8,592,000 bbl. in 1922; stocks on hand at the end of April, 1923, totaled 11,450,000 bbl. as against 14,470,000 bbl. for April 1922.

For the first quarter of 1923 (January, February and March) production totaled 25,669,000 bbl. as compared with 15,254,000 bbl. for the same period last year; shipments for the first quarter of 1923 were 21,708,000 bbl. as against

13,218,000 bbl. for the same period in 1922.

For the year 1922 the total production was 114,789,984 bbl. and shipments were 117,701,216 bbl.

Bookings of Steel Castings

The Department of Commerce announces that May bookings of steel castings made a slight decline from April, based on reports received by the Bureau of the Census in co-operation with the Steel Founders' Society. The bookings in May by companies representing over two-thirds of the commercial castings capacity of the United States amounted to 89,463 tons, as against 90,968 tons in April. Bookings for both railway specialties and miscellaneous castings declined.

The accompanying table shows the bookings of commercial steel castings for the past five months by 65 identical companies, with a monthly capacity of 96,900 tons.

BOOKINGS OF COMMERCIAL STEEL CASTINGS

Month 1923	Total Net Tons	Total Per Cent of Capacity	Railway Specialties Net Tons	Railway Specialties Per Cent of Capacity	Miscellaneous Castings Net Tons	Miscellaneous Castings Per Cent of Capacity
January	100,605	103.8	47,879	125.0	52,726	90.0
February	90,152	93.0	39,845	104.0	50,307	85.8
March	143,564	148.2	76,409	199.5	67,155	114.6
April	90,968	93.9	39,610	103.4	51,358	87.6
May	89,493	92.4	38,788	101.3	50,705	86.5

Steel Industry's Size Shown by Census Statistics

The Department of Commerce announces that, according to reports made to the Bureau of the Census, the value of products of establishments engaged primarily in steel production and the rolling of iron and steel products amounted to $1,481,659,000 in 1921, as compared with $2,828,902,376 in 1919 and $918,664,565 in 1914, a decrease of 48 per cent from 1919 to 1921, but an increase of 61 per cent for the seven-year period from 1914 to 1921. In 1921 reports were received from 494 establishments, a decrease of 6 from the number reporting in 1919, but an increase of 67 over those for 1914.

The decrease in the value of products has been accompanied by decreases in the number of persons employed, in the total amount paid for salaries and wages, and in the cost of materials used. In January, the month of maximum employment, 293,284 wage earners were reported; and in July, the month of minimum employment, 183,024, the minimum representing 62 per cent of the maximum. The average number of wage earners employed during the year was 235,515, as compared with 375,088 in 1919 and 248,716 in 1914.

Municipal Bond Sales for May

The aggregate of bonds disposed of by states and municipalities throughout the United States during May, according to the monthly survey of the *Commercial & Financial Chronicle*, New York, was considerably larger than during April, but when comparison is made with May of last year the tendency toward more moderate totals, noticeable the past few months, is still in evidence. The disposals in May were $91,873,006; in April, $78,131,220; and in May, 1922, $106,878,872.

Illinois made the largest contribution toward the month's total in the form of two issues of bonds aggregating $17,000,000, of which $10,000,000 was for a bonus to war veterans and the remaining $7,000,000 for road construction. The latter block was a 4-per cent issue which sold at a price of $97, giving a yield of 4.41 per cent. Among other large issues of bonds were those of $4,000,000 at Atlanta, Ga., for waterworks, schools, sewers and a viaduct all bearing 5 per cent; seven issues at Winston-Salem, N. C., aggregating $2,465,000 for public improvements;

REPRESENTATIVE PUBLIC BOND SALES DURING MAY AND JUNE, 1923

State	Purpose	Amount	Rate Per Cent	Sold For	Basis	Dated	Maturity	Purchased By
Illinois	Roads	$7,000,000	4	97.0	4.41	May 1, 1923	1936–37	Syndicate (Guaranty Trust Co., New York and others)
Maryland	Roads	1,650,000	4½	101.57	4.30	June 15, 1923	1926–38	Alexander Brown & Sons, Baltimore, and others
County								
St. Louis, Minn.	Roads	1,500,000	5	101.40	4.78	Jan. 1, 1921	1931	Syndicate (Redmond & Co., N. Y., and others)
Ramsey, Minn.	Road and bridge	1,000,000	4½	101.44	4.60	.....	1924–43	Syndicate (Estabrook & Co., N. Y., and others)
Abington, Pa.	School	350,000	4½	102.596	4.05	June 1, 1924	1933–53	Janney & Co., Phila.
Baltimore, Md.	Sewage	31,000	4½	102.452	4.39	June 1, 1923	1948	J. A. W. Iglehart & Co., Baltimore
Calcasieu, La.	Navig. Channel	2,750,000	5½	100.60	5.45	Oct. 1, 1922	1923–52	Sutherlin, Barry & Co., New Orleans; Caldwell & Co., Nashville
Hancock, Ind.	Road	13,860	4½	100.04	4.74	May 15, 1923	1924–33	Peoples State Bank, Indianapolis
Greene, Ind.	Road	144,000	5	101.0	4.80	May 15, 1923	1924–33	First National Bank, Linton, Ind.
Hennepin, Minn.	Road	2,000,000	4½	101.47	4.52	June 1, 1923	1928–42	Bankers Trust Co., N. Y.
Lake, Ohio	Water	225,000	5	101.53	4.78	April 1, 1923	1925–42	Richards, Parish & Lamson, Cleveland
La Porte, Ind.	Road	82,000	5	100.97	4.80	May 15, 1923	1924–33	Fletcher American Co., Indianapolis
Rock, Wis.	Road	200,000	5	102.13	4.82	June 1, 1919	1933	Harris Trust & Savings Bank, Chicago
Routt, Colo.	School	27,000	5½	103.919	5.19	June 1, 1923	1943	Janus N. Wright & Co., Denver
Wasco, Ore.	Road	200,000	5	103.10	4.59	May 15, 1923	1928–37	Ferris & Hardgrove, Spokane
Gibson, Ind.	Road	18,400	5	100.87	4.82	Apr. 15, 1923	1924–33	G. L. Payne & Co., Indianapolis
Butler, Ohio	Bridge	68,956	5	100.52	4.92	May 15, 1923	1924–37	Prudden & Co., Toledo
Calhoun, S. C.	School	60,000	5½	100.02	5.24	Jan. 1, 1923	1924–44	Detroit Trust Co., Detroit
Asheville, N. C.	Road	310,000	5½	104.67	4.89	Feb. 1, 1923	1933–53	Stacy & Braun, Toledo
Sussex, Del.	Road	300,000	5	103.05	4.80	Jan. 1, 1923	1931–70	Farmers Bank, Georgetown
Montgomery, Ohio	Water	40,000	5½	104.55	4.98	Apr. 1, 1923	1925–44	A. C. Allen & Co., Chicago
Township								
Dannemora, N. Y.	Road	8,000	5	101.21	4.73	Feb. 1, 1923	1925–32	Geo. B. Gibbons & Co., N. Y.
Montville, Ohio	Road	23,626	6	101.75	5.62	Apr. 1, 1923	1924–31	Chagrin Falls Banking Co., Ohio
Portage Pa.	School	100,000	4½	102.91	4.34	July 1, 1923	1933–53	Redmond & Co., Pittsburgh
Ripley, Ind.	School	78,000	5	101.88	4.73	May 15, 1923	1924–38	State Bank of Carthage, Ind.
Salem, Ohio	School	30,000	5½	102.70	5.17	Apr. 1, 1923	1924–43	Sidney, Spitzer & Co., Toledo
Municipality								
Atlanta, Ga.	Public works	84,000,000	5	104.44	4.59	Jan. 1, 1921	1925–51	J. H. Hilsman & Co., Atlanta; Stacy & Braun, Toledo, O.
Winston-Salem, N. C.	Streets, sewers, public works	2,465,000	4½–5½	100.00	4½–5½	May 15, 1923	1924–61	Syndicate (Harris, Forbes & Co., N. Y., and others)
Kansas City, Mo.	Water-works	2,500,000	4½	102.089	4.34	July 1, 1922	1942	Syndicate (Blodget & Co., N. Y., and others)
Cleveland, O.	Public works	1,970,000	4½	100.28	4.465	Mar. 1, 1923	1924–47	Otis & Co., Cleveland; Blake Bros. & Co., Boston
Flint, Mich.	Public works	1,875,075	4½	100.01	4.49	June 1, 1923	1924–48	Seipp, Princell & Co., Chicago
Charleston, S. C.	School	100,000	5	103.33	4.76	July 15, 1923	1948	Hanchett Bond Co., Chicago
Chicopee, Mass.	Water and paving	193,000	4½	101.517	4.16	June 1, 1923	1924–33	Old Colony Trust Co., Boston
Herkimer, N. Y.	Water and sewer	36,000	5	103.85	4.50	June 1, 1923	1924–43	Sherwood & Merrifield, N. Y.
Jersey City, N. J.	School	2,228,000	4½	103.47	4.44	June 1, 1923	1924–57	Harris, Forbes & Co., N. Y.; Nat. City Bk., N. Y. Bankers Trust Co.
Jersey City, N. J.	Gen. imp't.	2,046,000	4½	103.29	4.44	June 1, 1923	1924–55	Harris, Forbes & Co., N. Y.; Nat. City Bk., N. Y Bankers Trust Co.
Muskegon, Mich.	Sp. impv't.	103,500	4½	98.16	4.89	June 1, 1923	1924–33	Detroit Trust Co., Detroit
Newport, R. I.	Road	50,000	4½	100.06	4.40	June 1, 1923	1924–38	Merrill, Oldham & Co., Boston
Northampton, Mass.	Sewer	20,000	4½	100.60	4.13	June 1, 1923	1924–33	Harris, Forbes & Co., Boston
Portland, Ore.	Water	2,200,000	4½	100.077	4.49	July 1, 1923	1934–43	Harris Trust & Savings Bank, Chicago
San Antonio, Tex.	School	1,000,000	5	102.76	4.76	July 1, 1922	1924–62	Syndicate (Halsey, Stuart & Co. and others)
Jacksonville, Fla.	Street	315,000	5	101.05	4.87	May 1, 1923	1933–38	G. B. Sawyers Co., Jacksonville
Cedarhurst, N. Y.	.....	100,000	5	105.89	4.40	Mar. 1, 1923	1924–48	Sherwood & Merrifield, N. Y.
Columbia, S. C.	School	150,000	5	103.01	4.76	June 1, 1923	1928–57	L. S. Rosensteel & Co., Cincinnati
Des Moines, Ia.	Water	450,000	4½	100.15	4.48	Apr. 1, 1923	1934–43	Geo. B. Gibbons & Co., N. Y.
Omaha, Neb.	Street	600,000	4½	100.17	4.49	May 1, 1923	1943	B. J. Van Ingen & Co., N. Y.
Croton, N. Y.	Road	15,000	4½	100.533	4.43	June 1, 1923	1925–39	Farson Son & Co., N. Y.
Bessemer City, N. C.	Street and water	60,000	6	102.37	5.70	May 15, 1923	1926–50	Caldwell, Mosser & Williams, Chicago
Pottstown, Pa.	Sewer	200,000	4½	102.579	4.07	.....	1933–53	National Bank & Pottstown, Pa.
South Pasadena, Cal.	School	110,000	5	102.02	4.79	June 1, 1923	1929–45	Wm. R. Staats Co., Los Angeles

$2,500,000 for water-works at Kansas City, Mo.; $2,000,000 for a sea wall at Corpus Christi, Texas; $1,970,000 at Cleveland, Ohio, and $1,875,000 at Flint, Mich.

The number of municipalities emitting permanent bonds and the number of separate issues made during May, 1923, were 541 and 373 respectively. This contrasts with 448 and 632 for April, 1923, and with 647 and 868 for May, 1922.

Of the 50 representative bond issues included in the tabulation on p. 1107, one sold at par, 47 above par, and 2 below par. The yields ranged from 4.05 to 5.07, and the rate of interest from 4 to 6 per cent.

Large Contracts Let During Week

Among the week's announcements of contracts awarded in Construction News, pp. 363 to 378, are the following:

Apartment, Chicago, Ill., to B-W Construction Co., $3,500,000.

Power development, Quebec, Canada, to Morrow and Beatty, Peterboro, Ont., $3,000,000.

Apartment, New York, N. Y., to I. W. Stemmler, Jr., Inc., $1,500,000.

Memorial, Kansas City, Mo., to Westlake Construction Co., St. Louis, $1,142,250.

Hotel, Shreveport, La., to Ault and Burden, Little Rock, Ark., $1,000,000.

Bids Wanted on Big Jobs

Among the projects on which bids are either asked or will soon be called for, in Construction News, pp. 363 to 378, are the following:

Office building, New York, N. Y., for G. Backer Construction Co., $1,000,000.

Sewer, Los Angeles, Calif., for Board of Public Works, $12,000,000 bond issue.

Weekly Construction Market

THIS limited price list is published weekly for the purpose of giving current prices on the principal construction materials, and of noting important price changes on the less important materials. Moreover, only the chief cities are quoted.

Valuable suggestions on costs of work can be had by noting actual biddings as reported in our Construction News section.

The first issue of each month carries complete quotations for all construction materials and for the important cities. The last complete list will be found in the issue of June 7; the next, on July 5.

Steel Products:	New York	Atlanta	Dallas	Chicago	Minneapolis	Denver	San Francisco	Seattle	Montreal
Structural shapes, 100 lb.	$3.64	$4.30	$4.50	$3.40	$3.55	$4 20	$3.95	$4.10	$4.25
Structural rivets, 100 lb.	4.40	5.00	4.95	3.75	4.25	5.40	5.00	4.75	6.00
Reinforcing bars, ¾ in. up, 100 lb.	3.54	4.25	+3.75	3.32½	3.45	3.85	3.65	4.10	4.00
Steel pipe, black, 2½ to 6 in. lap, discount	44%	52%	45%	47%	53-5%	36%	35.2@47.6%	40%	32.76
Cast-iron pipe, 6 in. and over, ton	62.50@63.50	55.00	63.00	60.20	60.50	69.00	60.00	70.00	60.00
Concreting Material:									
Cement without bags, bbl.	2.70@2.80	2.85	2.25	2.20	2.39	2.84	2.71	2.90	2.25
Gravel, ¾ in., cu.yd.	2.25	1.90	2.25	2.00	1.85	1.90	2.15	1.25	1.50
Sand, cu.yd.	1.25	1.24	1.95	2.00	1.25	1.00	1.50	1.25	1.25
Crushed stone, ¾ in., cu.yd.	1.75	2.00	2.50	2.00	2.25	3.50	2.15	3.00	1.90
Miscellaneous:									
Pine, 3x12 to 12x12, 20 ft. and under, M.ft.	—64.00	42.00	53.00	58.50	—43.25	60.00	41.00	32.00	90.00
Lime, finishing, hydrated, ton.	18.20	23.50	22.50	20.00	25.50	24.00	22.00	24.00	21.00
Lime common, lump, per bbl.	3.00@3.25	1.50	2.50	1.50	1.50	2.70	1.75	2.80	10 00
Common brick, delivered, 1,000	23.50	14.00	12.90	11.00	17@19	12.00	15.00	13.00	16.50
Hollow building tile, 4x12x12, per block	Not used	.109	.115	.1032	.0836	.065	....	.11	.115
Hollow partition tile 4x12x12, per block	.1573	.109	.115	.0825	....	.065	.108	.11	.....
Linseed oil, raw, 5 bbl. lots, gal.	1.16	1.24	+1.36	—1.29	1.29	1.39	1.24	.86	1.38
Common Labor:									
Common labor, union, hour.	.75	.35	.....	.....	.....	.50@.55	.55	....	....
Common labor, non-union, hour.	.....	.30	.30@.50	.85	.55	.35@.50	.50	.50@.62½	+.30@.35

Explanation of Prices—Prices are to contractors in carload lots unless other quantities are specified. Increases or decreases from previous quotations are indicated by + or — signs. For steel pipe, the prevailing discount from list price is given: 45-5% means a discount of 45 and 5 per cent. Charge is 15c. per 100 lb. for cutting reinforced steel into 2-ft. lengths or over.

New York quotations delivered, except sand, gravel and crushed stone, alongside dock; common lump lime, in 280-lb. bbl. net, and hydrated lime f.o.b. cars; tile "on trucks"; linseed oil and cast-iron pipe f.o.b.

Labor—Concrete laborers' rate, 81½c.; building laborers (pick and shovel men), 75c. per hr.

Chicago quotes hydrated lime in 50-lb. bags; common lump lime per 180-lb. net. Lumber delivered on job.

Minneapolis quotes on fir instead of pine. Brick, sand and hollow tile delivered. Cement on cars. Gravel and crushed stone quoted at pit. We quote on brown lime per 180-lb. net; white is $1.80 for Kelly Island and $1.70 for Sheboygan. Common labor not organized.

Denver quotes on fir instead of pine. Cement "on tracks"; gravel and sand at pit; stone on cars; lime, brick, hollow tile and lumber on job. Tile price is at warehouse. Linseed oil, delivered, in iron bbl. Common lump lime per 180-lb. net.

Atlanta quotes sand, stone and gravel per ton instead of cu.yd. Common lump lime per 180-lb. net.

Dallas quotes lime per 180-lb. bbl. Steel, cement, cast-iron pipe and crushed stone f.o.b. cars, other materials delivered.

San Francisco quotes on Heath tile, size 5¼ x 8 x 11½. Prices are all f.o.b. warehouses except C. I. pipe, which is mill price plus freight to railway depot at any terminal. Common lump lime per 180-lb. net. Lumber prices are to dealers in yards at San Francisco, for No. 1 fir common.

Seattle quotes on Douglas fir (delivered) instead of pine. Lump finishing lime per 180-lb. net. Hollow building tile delivered. Hydrated lime in paper sacks. Sand and gravel at bunkers.

Montreal quotes on pine lumber. Sand, stone, gravel and lump lime per ton. Cement, lime and tile are delivered; sand, gravel and stone on siding; brick f.o.b. plant; steel and pipe at warehouse. Hollow tile per ft. Cement price is in Canadian funds (the Canadian dollar stands at 97.74). Bag charge is 80c. per bbl. Discount of 10c. per bbl. for payment within 20 days from date of shipment. Steel pipe per 100 ft. net; 2½-in., $32.76; 6-in., $108.

Changes Since Last Week

Steel prices are tending toward lower levels, with the greatest weakness in steel sheets and reinforcing bars. Quotations as low as $2.35 per 100 lb. are being offered on bars at Pittsburgh mills; the maximum, however, does not exceed $2.40. New demand for plates and shapes shows some improvement; quotations mainly at $2.50 per 100 lb., f.o.b. mill, with $2.60 asked for immediate shipments.

Warehouse prices show little change on steel, concreting materials, brick, lime and hollow tile. Linseed oil, however, advanced 1c. in Dallas and declined 8c. per gal. in Chicago, during the week which is covered by this report.

Yellow pine timbers dropped $1 per M. ft. in New York and Douglas fir, $1.50, in Minneapolis. The demand for yellow pine is weaker with orders on hand below sales. Recent rains have tied up production considerably, in cutting areas.

Maximum common labor rate in Montreal advanced to 35c. as against 30c. per hr.

New York bricklayers are still on strike, on jobs covered by the Mason Builders' Association, demanding contract of $12 per day for two years. The employers extended an offer of $11 per day for 2½ yrs., which was rejected by the unions with the resultant threat of a "lock-out" on the part of the builders. Twelve school contractors, however, signed the agreement to pay $12 per day for two years and to guarantee continuous employment to the bricklayers, during that period.

St. Louis plasterers are on strike, demanding $14 as against $12 per day. Fear is expressed that the move on the part of the plasterers will be followed by demands from other trades. The plasterers, hodcarriers and laborers have already voted to demand an increase of $1 per day.